REVIEW

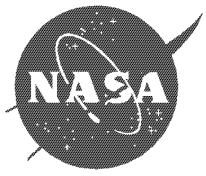
MISSION OPERATIONS AND DATA SYSTEMS DIRECTORATE

Landsat-7

Image Assessment System (IAS)

Integration and Test Plan

April 1997



National Aeronautics and Space Administration

Goddard Space Flight Center
Greenbelt, Maryland

REVIEW

Image Assessment System (IAS) Integration and Test Plan

April 1997

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Preface

This test plan covers the testing of the Image Assessment System (IAS) which will be used by testing personnel. The scope of the system is defined in the attached planning model diagrams (Image Assessment System (IAS) Context Diagram) in Appendix A.

This test plan is a contractual requirement for the Code 514 portion of the Mission Operations Support (NMOS) contract with the Goddard Space Flight Center (GSFC) site of the National Aeronautics and Space Administration (NASA).

This document is controlled by the IAS Project of Code 514 and may be changed by Document Change Notice (DCN) and/or revision procedures. Comments and questions regarding this specification should be directed to:

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Abstract

This document provides a comprehensive plan for the subsystem integration and system-level testing of the Landsat 7 Image Assessment System (IAS). This plan documents the testing process from test preparation through test status summary reporting, and includes test methodology, functional responsibilities, test resource requirements constraints, and test set information.

REVIEW

Section 1 - Introduction -

1.1 Purpose and Scope

This document provides a comprehensive plan describing how the Integration and Test Department integrates IAS subsystems, and performs tests to qualify the system for release to the IAS Project Manager.

This plan covers the verification of IAS system requirements, internal interfaces at the subsystem level, and external interfaces with other elements of the Landsat Ground System and IAS. The overall Landsat 7 test, hierarchy and responsibilities, including the Landsat 7 Ground Station (LGS), and the EROS Data Center Distributed Active Archive Center (EDC DAAC), can be found in the Landsat 7 Ground System Integration and Test Plan.

1.2 IAS Overview

The Image Assessment System (IAS) is an element of the Landsat-7 Ground Data Handling Segment, and is responsible for off-line assessment of image quality to ensure compliance with the radiometric and geometric requirements of the spacecraft and the ETM+ sensor throughout the mission's life.

In addition to its assessment functions, the IAS is also responsible for the radiometric and geometric calibration of the Landsat 7 satellite and Enhanced Thematic Mapper Plus (ETM+). Initial calibration data, in addition to sensor characteristics and models are received pre-launch from the ETM+ contractor (SBRS) and the Space Segment Satellite (LMMS). The IAS periodically performs radiometric and geometric calibration and passes calibration coefficient updates directly to the EROS Data Center Distributed Active Archive Center (EDC DAAC) and to IGSs through the MOC. Anomalies are reported to the Mission Operations Center (MOC), Landsat Processing System (LPS), EDC DAAC, and Mission Management Office (MMO) as needed.

The IAS obtains Level 0R data and products from the EDC DAAC. This data includes all bands, 0R image data, radiometric calibration data, Calibration Parameter File, Payload Correction Data, and Mirror Scan Correction Data. The IAS assesses image data by processing the data to Level 1R and 1G for assessment as Level 1 products. Image data are assessed with respect to their geometric and radiometric qualities on an individual sample and long term trending basis. Data quality assessments , and reports, are sent to the EDC DAAC and MOC.

1.3 Applicable Documents

1. National Aeronautics and Space Administration (NASA), Goddard Space Flight Censer (GSFC), 430-L-0002-H, *Earth Science Mission Operations Landsat 7 System Specification*
2. Martin Marietta Astro Space, *Landsat-7 Image Assessment System Operations Concept*, September 1994
3. Martin Marietta Astro Space, CDRL #A058, 23007610A, *Landsat-7 Program Coordinate System Standard, Rev. B*, December 1994
4. Martin Marietta Astro Space, CDRL No. A104, *Space Segment Calibration Plan*, August 1994
5. Computer Sciences Corporation, *Landsat-7 MOC to IAS Interface Control Document*
6. NASA, GSFC, 514-1 ICD/0195, Interface Control Document Between the IAS and the LPS
7. Hughes Information Technology System, 209-CD-013-002, *Interface Control Document Between ECS and the Landsat 7 Systeml.*
8. Computer Sciences Corporation, *SEAS System Development Methodology (SSDM)*, Copyright July 1989
9. NASA, GSFC, 514-1 ICD/0195, Landsat-7 Image Assessment System Element Specifications, Review October 1996.
10. Computer Sciences Corporation, *Landsat-7 Image Assessment System (IAS) System Design Specification, December 1996.*
11. Computer Sciences Corporation, *Landsat-7 Image Assessment System (IAS) Preliminary System Design*, December 1996.
12. Computer Sciences Corporation, *Landsat-7 Image Assessment System (IAS) Interface Definitions Document (IDD)*, December 1996.
16. Computer Sciences Corporation, 511-4ICD/0197 *Landsat-7 Mission Operations Center (MOC) to image Assessment System (IAS) Interface Control Document (ICD), January, 1997.*
13. NASA, GSFC, *Landsat-7 Image Assessment System (IAS) Operations Concept*, December 1994.
14. NASA,GSFC, 430-11-06-007-0, *Landsat 7 0R Distribution Product Data Format Control Book HDF Version, July 2, 1996 Review Draft.*
15. NASA,GSFC, 430-15-01-002-0, *Landsat 7 Calibration Parameter File Definition, February 6, 1997.*
16. Radiometry algorithm descriptions on the Web at URL http://1tpwww.gsfc.nasa.gov/LANDSAT/
17. Geometry algorithm Theoretical Basis Document (ATBD) on the Web at URL http://edcwww.cr.usgs/ias

1.4 IAS Integration and Test Strategy

During the implementation process, three groups, IAS, AIT, and EDC will be developing software simultaneously. IAS will develop system functions, AIT will implement the radiometric algorithms, and EDC will develop the geometric algorithms. The algorithm testing for radiometry will be tested with test cases prepared by the system test group and testing conducted as a joint test effort with developers and system testers. This testing will be very rigorous and detail to develop confidence during the system test phase. The EDC test group will also conduct rigorous geometry algorithm testing. Because these groups are remotely located the software will be migrated to a central depository, and the Configuration Management (CM) will control and configure the components into a integrated system. The IAS CM plan will established procedures which outline the initial acceptance of software and controlling the baseline. CM group will use CM tools to keep track of revisions and changes for software and hardware.

Prior to the beginning of the system test phase, the system test team will conduct a System Test Readiness Review(STRR) to assess the readiness for the system test phase. A successful go status from the STRR will allow CM to accept and configure the delivered software into a system ready for execution. The CM test plan will establish guidelines for integrating software/hardware and controlling the baseline, develop procedures to ingest the software from all development groups, and detail the method for resolving problems related to releases or execution of the system. Confidence test will be conduct to verify that the system is ready for formal system testing to proceed. This confidence testing is conducted by the CM group and system test..

The Test Team will develop a test plan that identifies what is to be tested for each release, it will further detail the test plan into test procedures that describe how testing is performed. Also, criteria for test completion and success will be formulated. The successful completion of the system test phase will allow the software to pass to the installation phase. During this phase the system engineer and the testers will confer about the capabilities of each release. If the objectives of that release are met, a installation team will install the release at the EDC site.

Section 2 - Test Activities -

This section presents an overview of testing and describes the typical activities performed by the test groups throughout the project lifecycle.

2.1 Test Preparation

The test preparation phase consists of test plan development, test tool preparation, test data generation, training of test personnel, and test environment preparation. At the end of the initial test planning phase, and prior to system testing of each release, preparation includes test procedure definition, the Test Procedures Walkthrough (TPW) and the System Test Readiness Review (STRR).

The test plan for IAS addresses internal interface testing, system-level testing and requirements verification, and external interface testing with other elements of the Landsat ground system. This document is the basis for all related test planning activities, including planning for test tool and test data needs.

Informal demonstrations and/or user's guides should be provided to test personnel for the following:

- IAS Operator Interface
- IAS Analyst Interface
- IAS database
- GTSIM
- GTEDIT
- Any test tool developed for IAS

More formal training may be required for Commercial-Off-The-Shelf(COTS) products and system software associated with IAS, and should include the following:

- UNIX
- ORACLE
- Requirements & Traceability Management (RTM) tool
- Polytron Version Control System (PVCS) tool

- Revision Control System (RCS) tool

If the implementation schedule requires multiple releases, after implementation of the first release, the software in development may be Release n, while the integration team is testing Release n-1 and Release n-2 is the system test baseline. In order to manage and ensure control of the software and environment configurations, integration and system test environments are separate from each other, and from development environments. For test environments, the IAS system engineers set up and configure all hardware elements and system software. Any modifications, including changes from standard installation process and/or the parameters that are set during installation, made to the hardware or system software are documented for configuration control. The appropriate test group, with support from the configuration management (CM) representative, controls the application software for the corresponding test environment. The subsystem integration group installs software as it becomes available for test, and rebuilds (i.e., exercises the full release instructions) before turnover to system test. Application software for the system test environment is installed as a full release (from no existing software) for delivery of full releases. For partial releases (e.g., emergency deliveries outside the scheduled deliveries), only those delivered application software components are built.

Testing follows the development of the software components for each release and is, therefore, dependent on the release process for the IAS. The plan describes the contents and the schedule of, as well as the specific requirements allocated to each release. The test cases corresponding to those requirements are the scope of the system test for that release (including requirements from previous releases). The incremental release approach provides feedback on quality, errors, and design concerns as early as the integration of the first release and facilitates improvements in subsequent releases.

Prior to each test execution phase, test procedures are developed to define the step-by-step execution and expected results of testing for a given release. Test procedures are red-lined during test execution to note any obvious variances from the original planning. After the test execution phase, the test procedures are updated and gathered as an appendix to the test plan, and used as a basis for procedures for subsequent releases.

Delivery package preparation begins in the test preparation phase. The turnover package started by development is the draft delivery package. The package is augmented with information from integration test and passed in the turnover to system test. The delivery package for a release is finalized with all attachments at the end of the system test for that release. Details of the delivery package contents are documented in Landsat 7 Image Assessment System Delivery Procedure.

At the end of system test preparation the test procedures walkthrough is held to review test execution steps and expected output, and the system test readiness review is held to assess whether or not the project is ready to transition to system test

2.2 Test Conduct

When test preparation is complete, the test group moves into the test conduct phase for the current release. The primary activities of this phase are test execution and analysis of the software functions and/or output files. In addition, status and progress are reported, and change requests are generated. For a release that will be released to the customer, the delivery package is finalized during the system test conduct phase.

2.3 Test Management

Test management of the IAS includes preparation of weekly test status reports, daily productivity status reports, and formal STRRs for system testing. A summary of the test execution, problem reports, and major milestones is provided in the weekly status reports, along with the overall progress of testing. The weekly test status reports are provided to CNMOS management during the entire test life cycle and incorporated into the weekly IAS status reports provided to Goddard Space Flight Center (GSFC). Productivity status information is provided during test conduct and contains totals of tests executed and Internal Configuration Change Request (ICCR) written. A summary of the major problems encountered and major milestones completed for the day is included with this report. The report is provided to the IAS test lead and is available for IAS project management and GSFC, if desired. Meetings on the test status are held periodically during the test execution phase, as needed.

2.4 Internal Configuration Control

Maintaining configuration control of IAS software, tools, data, and environments is necessary to minimize the effort and risks inherent in developing and testing changeable software. The Configuration Management section of the Integration and Test Department and the applicable test groups are each responsible for configuration control. These responsibilities are described in further detail in Section 5 of this plan.

2.5 Test Data

Development, integration, and system test personnel require data to test individual units, modules, subsystems, and the IAS system as a whole. The Generic Telemetry Data Simulator (GTSIM) will be used throughout the IAS lifecycle to generate raw wideband data in the format defined for the Enhanced Thematic Mapper Plus (ETM+) instrument of the Landsat 7 satellite. Section 7 of this document contains a more detailed discussion of test data requirements and sources.

2.6 Test Tools

IAS testing will verify low-level tasks in radiometric and geometric processing, and will depend heavily on data dump and analysis tools. Integration test will require drivers and stubs to stand in for software scheduled for later development. To eliminate dependence on the development schedules of other facilities, IAS will develop interface simulators. Specifics on test tools and tool configuration are documented in Sections 5 and 7, respectively.

Section 3 - Subsystem Integration Testing -

This section describes the preparation for and execution of subsystem integration testing for the IAS application software.

3.1 Objectives

The integration test effort documented in this plan is designed to verify software subsystem interfaces, including the data passed in those interfaces. The integration team also tests the IAS software to verify accuracy in mathematical algorithm implementations, to exercise error handling paths and verify path coverage in general, and to test functional performance.

3.2 Test Cases

Integration tests are designed using the Interface Definition Document (IDD) to map interactions between subsystems. A class of valid inputs is identified for each interface, and tests are defined to use a random or representative subset of those values. Invalid inputs and boundary conditions are identified, and one test case may be used to verify nominal, boundary and error conditions by changing input criteria.

An integration test case consists of the objective of the test, a description of the test case, prerequisites and dependencies, initialization and input requirements for the test, expected output and test evaluation criteria.

3.3 Test Execution

Based on the contents of a release, the integration team will identify the test cases to be executed. Prior to the first turnover, integration test will hold an informal walkthrough to present the tests planned for the current release. A test is considered unsuccessful when the results do not match the expected output; early review and discussion of the integration test plan by development personnel is essential to streamline test execution.

Installation of software subsystems and test execution is performed in the subsystem integration test environment, separated and under separate configuration control from the development environment. Test execution is scheduled based on identified test dependencies and the order in which subsystems are turned over to the integration team.

3.3.1 Internal Interfaces

Unit and module integration is completed by the development team prior to software turnover to subsystem integration testing team. The team tests the interfaces between subsystems, including interfaces between IAS subsystems and external elements of the Landsat 7 Ground System (NOTE: external interfaces will be simulated for subsystem integration).

Integration tests will verify the interfaces between and among subsystems (i.e., each interface between two subsystems, and all interfaces among a group of subsystems), until the implemented software has been fully integrated. For early releases, when implementation of a given subsystem is not complete, test tools will substitute for undelivered units.

3.3.2 String Testing

Software turnovers to subsystem integration are expected to be staggered according to the development schedule for each subsystem. The last turnover of an IAS subsystem must occur at least one week before turnover to system test. When the subsystems have been integrated, tests will be executed to verify the data and process flows from initial input to the IAS through final output from the IAS.

The Landsat 7 Ground System Integration and Test (I&T) will be supported by released or engineering versions of the IAS software (dependent on Ground System I&T schedules). For subsystem integration, external elements may be simulated to verify the IAS software at those interfaces and to flow data from end to end of the IAS.

3.3.3 Confidence Tests

At the end of the integration test phase, and in preparation for system test, the two test teams will execute confidence tests. Configured data sets are processed by the IAS software in the integration test environment. Behavior of the software and data results are recorded. After the IAS software is installed in the system test environment, the same configured data sets are processed in that environment. Results are compared to integration test results to obtain a quick confidence level in the installation process and software.

3.4 Analysis and Reporting

The level of analysis required to determine the status of an executed test will vary with the test. The expected results documented in each test case description range from observation of an event to analysis of data integrity for a file. Any test whose results fail to match the expected output is an unsuccessful test, and the integration team will refer such anomalous or unexpected test results to the software development team for further analysis.

An informal, daily report of integration test progress and unresolved issues will be prepared by the test team for project management. A more formal accounting of tests executed versus tests scheduled; successful and unsuccessful test numbers; number, priority and type of ICCRs written and resolved; and status of integration test issues will be prepared on a weekly basis.

3.5 Problem Reporting

Software problems encountered during the subsystem integration test phase will be documented as ICCRs, using the Interactive CCR Automation System (ICAS) system. The ICCR process is simplified and controlled internally and the time to correct errors can be minimized without compromising configuration control in the integration environment. However, all the unresolved ICCRs from subsystem integration test will be placed under CRB control after software turnover to system test.

The number of procedural and set-up errors, or errors due to implementation changes, should be reduced by the test walkthrough. In order to eliminate unnecessary or incorrect error reporting even further development personnel should be available for consultation during integration test execution. If an error is serious enough to suspend test execution, integration

and development task leads will coordinate immediate analysis. Otherwise, integration test errors will be discussed at the daily status presentation before being entered into ICAS.

3.6 Subsystem Integration Test Summary

After software turnover to system test, the integration team will prepare an informal report of testing. The report is an overall evaluation of the integration test phase, including a summary of problems encountered and resolved, and a list of outstanding problems.

3.7 Lessons Learned

Immediately after turnover to system test, the integration test team holds a Lessons Learned meeting. Any problems encountered during the test phase are discussed, with an eye toward identifying process changes that can be implemented for the next integration test phase. Meeting minutes are prepared, listing action items and due dates. The integration task lead is responsible for follow-up for action items and process improvement initiatives. Meeting minutes will also be stored on server for history.

3.8 Subsystem Integration Test Schedule

The following is a schedule for subsystem integration test planning and execution for the three IAS releases. The date listed for each item is the COMPLETION date, unless otherwise indicated. All dates are relative to the date of the turnover to System Test. The planned turnover dates will be maintained in the Release Implementation Plan.

Activity	Completion Date
Test data selection	turnover - 9 weeks
Test data identification	turnover - 9 weeks
Integration test walkthrough	turnover - 8 weeks
Test environment setup/cleanup	turnover - 5 weeks
Test data generation/verification	turnover - 4 weeks
First turnover of subsystem(s)	turnover - 4 weeks
Last turnover of subsystem(s)	turnover - 2 weeks
Subsystem integration	turnover - 1 weeks
String testing	turnover - 1 day
Turnover package preparation	turnover - 1 day
Turnover to system test	turnover + 0 days
Confidence testing	turnover + 3 days

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Section 4 - System Test -

4.1 Objectives

The primary objective of system testing is to verify the functional, operational, and performance requirements allocated to the IAS. The Landsat 7 Image Assessment System (IAS) Element Specification requirements are the basis for the system test design defined in this plan.

In addition to requirements verification, system testing includes running operational scenarios, simulating a "day in the life" for operational software. End-to-end testing is also performed, encompassing IAS software functions and interfaces with external elements of the Landsat 7 ground system.

4.2 Test Case Definition

The Landsat 7 Image Assessment System (IAS) Element specification (ES), Landsat 7 Image Assessment System (IAS) Operations Concept, Landsat 7 ETM+ Geometric Calibration Plan, and Landsat Radiometric algorithm description documents are the basis for defining system test sets and test cases. System test cases are mapped to the Element Specification requirements and are designed to exercise IAS processes in a manner that verifies that allocated requirements are satisfied. For requirements that are satisfied .For requirements that are satisfied by operational procedures rather than software, test cases follow the scenarios defined in the operations concept document.

Functional tests focus on valid, invalid or incomplete keyed and data inputs to the system. Performance tests focus on data volumes capabilities, response times and data throughput. Operational scenario testing exercises system functions in combinations that are most likely to occur during daily operations.

System test cases are grouped under functional test sets. A system test set consists of a purpose, high level description of the tests to be performed, testing dependencies, test methods and an overview of expected output. Test cases include a description of the test and data, and a list of the requirements satisfied with successful execution. Because test sets group similar tests together, the data, resources and expected results are defined at the test set level. When individual tests diverge from the test set norm, more details of resources and output are included at the test case level.

4.2.1 Test Ordering and Dependencies

System test cases are grouped into test sets by IAS function. Tests within a set are generally independent of each other, but may follow a data flow that defines the order of test execution. Likewise, test sets must be executed in a specific order (e.g., data receipt must precede data processing), unless simulations are used to satisfy the prerequisites for test execution. Details of test dependencies are documented along with the description of each test set.

4.3 Test Procedures

The system test procedures consist of step-by-step instructions for executing individual test cases. Test procedures are written based on details of IAS operations documented in the user's guide. An initial set of procedures is developed for a release, presented at a Test Procedures Walkthrough, and modified as necessary before testing begins. The set of test procedures baselined for the release is added as an appendix to the I &T Plan. During system test execution, the procedures are red-lined to adjust for software changes and omissions in test steps. At the end of the system test phase, the procedures are updated per red-lines, and form the basis of the next release's test procedures. At the completion of the last system test phase, the I & T Plan contains the comprehensive test procedures for the IAS.

Test procedures typically consist of

- test set name and number
- test case number and description
- test execution dependencies
- test data description
- test tools required
- check-off list of steps to execute test
- check-off list of expected results
- success criteria, where applicable
- requirements satisfied by successful execution

Because many IAS requirements map to low-level tasks within the IAS processing function, system test cases will not have a one-to-one correspondence to requirements. For more complicated test cases, the test steps will be mapped to expected results, which will be mapped to individual requirements. This design will allow test cases and procedures to follow the operation of the IAS system without complicating the analysis required to assess test results.

4.4 Test Procedures Walkthroughs

A Test Procedures Walkthrough is held for each release as part of the test planning phase. The TPW is conducted to ensure that the proposed test procedures adequately describe the operation of the system and verify the system requirements implemented for the current release. The walkthrough should be attended by representatives from development, integration and test, systems engineering, product assurance and project management.

A review package, containing all test procedures to be executed during the system test phase, should be distributed a week before the scheduled TPW; reviewers should have sufficient time to prepare comments and questions before the meeting.. At the walkthrough, an overview of the test methods, test data, tools and other resources employed for testing the release is presented by system test personnel. Review of the individual procedures is driven by comments on test execution steps, expected output and/or success criteria.

4.5 System Test Readiness Review

A System Test Readiness Review is conducted to assess the readiness of the system, the test environment, and the system test team for system testing. The degree of formality of the STRR depends on scope, size, and criticality of the system.

The STRR should be conducted at least one week before the scheduled turnover to system test, but less mature systems (i.e., early releases) should be held as far in advance of the turnover as possible. The system test team facilitates the meeting, but the readiness of different areas will be presented by the following groups:

(1) Software support - software development

(2) Subsystem I&T results - integration test

(3) Test environment - configuration management

If the STRR assessment shows that any element reviewed is not ready, a plan for implementing corrective action should be established, within a time frame that allows for reassessment before turnover.

4.6 Test Execution

The test sets and test cases documented in this test plan are high level descriptions of test to be performed during the lifecycle of the IAS project. Details of test cases will be documented in the test procedures associated with each release.

All tests are executed as described in the test procedures. Problem reports are generated when discrepancies exist between the expected output and the actual results of the test. Expected outputs are noted in each test procedure, and concurred upon by the project at the Test Procedures Walkthrough.

The success criteria stated for each test case act as a pass/fail indicator for statistical reporting during the system test phase. Success criteria are also reviewed at the Test Procedures Walkthrough.

In addition to providing test execution steps and criteria for assessing test results, the test procedures are used as test logs. The procedure is written as a checklist, which allows the tester to indicate exactly where problems were encountered, which test step or output was the basis for ICCR generation, the date of test execution, the status of test results, and any comments pertinent to the test.

4.6.1 Functional and Performance Tests

Functional tests are defined to verify functional requirements specified in the IAS Element Specification. Nominal input conditions are defined for every functional requirement test, abnormal input conditions (e.g., incorrect input, incomplete or invalid data) are defined for appropriate and representative tests. Functional tests are executed during all releases, and are the primary focus of the first two releases of the IAS. They also become the basis for building the regression test set for subsequent releases.

For a given release, functional tests are scheduled to exercise

- new functions
- most used functions
- most important functions
- hardest to develop functions, if applicable
- least time to develop functions, if applicable
- least unit-tested functions, if applicable.
- Performance tests are defined to verify the performance requirements specified in the IAS ES, such as
- overall performance (system monitoring and utilization)
- data volume
- storage limits
- usability (operator interface and user's guide)
- reliability recovery and availability
- response times.

System tests for performance verification are executed, when the software is fully implemented and the hardware is available. Performance tests cases are defined mainly in the System Integration Test section of this document.

4.6.2 External Interfaces

These tests are defined to verify the IAS software that supports interfaces with external elements of the Landsat 7 Ground System, as specified in the IAS ES. Tests will be executed in all releases of the IAS; release 1 testing is expected to utilize interface simulators, while subsequent releases will require coordination with the facilities with which the IAS will interface. However, if the external facilities are available before release 2 testing, release 1 software will be used for external interface test.

4.6.3 Operational Scenarios

Operational scenario testing is defined to verify the requirements in the IAS ES that are not satisfied by software or hardware implementation. In addition, scenarios described in the IAS Operations Concept document are tested to verify the feasibility of the workload assigned to the IAS operators.

Operational, performance, and end-to-end tests are combined to provide "day in the life" testing in which the IAS is up-and-running for a minimum of 24 hours.

4.6.4 End-to-End Testing

End-to-end testing verifies the IAS capability to support input-to-output testing. Data is processed through the entire system, from the receipt of LOR file from DAAC and creates L1R and L1G products, characterization data and reports, and calibration parameters and reports. Different scenarios are established for nominal processing, reprocessing and processing data with correctable errors. End-to-end testing is also employed in system integration testing and performance verification.

4.6.5 Confidence and Regression Tests

Both confidence and regression tests use a baselined set of data to make a quick, initial assessment of the IAS software installed in the system test environment.

For confidence testing, nominal data successfully processed in the integration test environment are passed to the system test group to process. Duplicate results in the two environments provide a high level of confidence in the release process. Confidence tests are executed starting with the first turnover of the first release.

In contrast, regression tests are executed for turnovers made after a stable software baseline has been verified in the system test environment. After successful execution, nominal functional test cases may be moved to the regression test set. The data associated with the original tests and the test results are configured for use and comparison in later regression testing. Changes to the IAS software that affect the results of baselined test cases may affect the regression test set, requiring certain tests to be suspended from regression testing until a new data set has been tested and configured.

After an initial regression set can be baselined, regression tests are executed for each subsequent turnover to the system test group. A subset of the regression test set is identified based on the contents of the individual turnover; the full regression set is executed prior to delivery for releases. Wherever possible, regression testing is automated to run without impacting test time.

4.7 Verification Methodology

Most requirements will be verified by test, in which expected results derived from the requirements are the basis for assessing actual test results. Those requirements not verified by testing are verified by inspection, analysis or demonstration. Data formats and report contents are typically verified by inspecting the output for compliance with the applicable requirements. Inspection is also performed on hardware, code, program design language (PDL), and other documentation. Performance requirements are

verified by test followed by analysis to further interpret the results. Requirements relating to the operator interface may also be verified by human factors analysis. Requirements that are satisfied by implementing operational procedures can be verified by demonstrating that the procedure are practical and possible. The verification methodology for tests is noted along with the test set description.

4.8 Analysis and Reporting

Most of the analysis performed during the system test phase is a comparison of data files. For releases that employ regression testing, the output files from newly executed tests are analyzed with respect to the configured output of the regression tests. Output data from individual tests are analyzed with respect to the input data, for both nominal and anomalous data handling. All data generated by the IAS is collected and analyzed to determine whether output files meet the established criteria documented in the system test procedures.

After completion of the system test phase for a release, each test procedure is reviewed for completeness, and the status of its associated requirement(s) is documented for the system test verification matrix. The RTM tool will be used to generate the traceability matrix, and to store the status of test execution.

Test progress statistics are collected on a daily basis, status reports are prepared on a weekly basis and included in the weekly reports to GSFC. At the conclusion of all testing for a release, a test status summary report is generated, based on the results of requirements verification during the system test phase. The test report for an undelivered release is less formal, and available within two weeks of the end of testing. Reports for software release testing are available within a month of test completion.

4.9 Anomaly Reporting and Change Control

Any tests outlined in this document that fail to generate the expected results may be rerun to verify that, if a problem does exist, it can be recreated and the test results maintain consistency. Problems that are not repeatable are still documented and noted as non-repeatable. ICCRs are documented through ICAS and reviewed by software engineering to determine whether they are in the scope of the IAS requirements and design implementation. ICAS maintains a database of the ICCRs for approvals, analysis, implementation, tracking and report generation.

Problems found during system test are resolved by interim turnovers of modified software, depending on the severity of the problem and the test time remaining until the delivery deadline. During test phases, the Configuration Review Board (CRB) will meet as often as necessary to make timely decisions on the disposition of software problems encountered during testing. The decision whether to change the system test software with emergency or patch turnovers will be made by the CRB, however, no changes will be made to the system test baseline without a formal turnover of configured software.

4.10 Requirements Traceability

To ensure that all requirements for the IAS are addressed, each system test case is mapped, using the Requirements and Traceability Management (RTM) tool, to the requirement(s) it is designed to verify. The mapping, by test case, is part of the System Test Sets section of this document. Section 10 contains the test requirements & verification matrix generated from RTM.

The initial test execution schedule is derived from the Image Assessment System (IAS) Software Implementation Plan, and is subject to change. Updates to the IAS System Test Requirements Verification Matrix are made after each Test Procedures Walkthrough (to update the test execution schedule), and after the completion of system testing (to update the test results). A requirements verification matrix is included in the delivery package for software releases.

4.11 Lessons Learned

At the end of release testing, or after software delivery to the customer, the system test team holds a Lessons Learned meeting. Any problems encountered, as well as successful procedures employed during the test phase are discussed. Test management personnel are in attendance and are responsible for resolution of issues and implementation of changes that require management level approval. Meeting minutes are prepared with action items and due dates, which should be scheduled for changes to be implemented before the next test execution phase.

4.12 Test Assumptions and C onstraints

Specific test assumptions are covered in the listing of resources required for each test set (i.e., it is assumed the specified resources will be available before the related tests are executed). Additionally, the system test group expects

- to have access to any tools used by development and integration for testing
- that a draft of the user's guide will be available approximately 5 weeks before the first turnover from integration test as a resource for test procedures development
- that the software turned over to system test will include "best guess" values for the static data in the database, and tools to automatically load that data
- that the minimum amount of system time (8 hours a day, 5 days a week) will be available during the test execution phase

The system test phase of the IAS is planned based on the software implementation plan and published schedules for development and test. Test schedules are affected by changes in turnover schedules, system availability, and additional release requirements.

Because the Landsat 7 satellite will not be launched before the completion of the last test phase, the test data sets in this test plan are simulated. Though the data will come from various sources (GTSIM, Landsat 4/5 data conversion tools, instrument I&T,

spacecraft I&T), none is guaranteed to duplicate data that will be received after launch. The results of testing are necessarily limited by the available data.

4.13 System Test Activities Schedule

The following is a generic schedule for system test planning and execution for each IAS release. The date listed for each item is the COMPLETION date, unless otherwise indicated. All dates are relative to the date of the turnover to System Test. The planned turnover dates will be maintained in the Software Implementation Plan.

Activity	Completion Date
Test case selection	turnover - 8 weeks
Test data identification	turnover - 8 weeks
Test procedures generation	turnover - 5 weeks
Test Procedures Walkthrough	turnover - 4 weeks
Test data generation / verification	turnover - 4 weeks
Test environment setup / cleanup	turnover - 2 weeks
System Test Readiness Review	turnover - 1 week
Dry run of the release	turnover - 1 week
1st turnover from Integration Test	turnover + 0 days
Confidence testing	turnover + 3 days
Last turnover from Integration Test	turnover + 4 weeks
Regression testing before delivery	turnover + 6 weeks
Test execution	turnover + 6 weeks
Delivery package preparation	turnover + 6 weeks
Release to customer	turnover + 6 weeks
Lessons learned meeting	turnover + 7 weeks
Test summary report	turnover + 10 weeks

Section 5 - Configuration and Data Management -

This section describes the configuration activities that pertain to the testing phases of the IAS. The Configuration Management section of the Baseline Engineering and System Test Department is predominantly responsible for configuration control.

5.1 Test Tools

Tools developed for testing the IAS will be documented (e.g. description, location, release used in) and place in a configured software library for reuse and access by all IAS personnel. Changes to the configured test tools will be controlled and tracked, and CM personnel will be responsible for maintenance of the configured test tool library.

Test tools will be made available to the operations staff when the IAS software is released. The tools will be provided as engineering versions and will not be formally delivered. Any modifications made by EROS Data Center (EDC) personnel to the tools are outside the scope of SEAS test, maintenance and configuration control.

5.2 Test Data

IAS test data will be configured and associated with a release baseline, but will not be a deliverable item. CM personnel will be responsible for maintaining a test data catalog and configured test tool library, and any changes to the configured test data will be tracked.

The data catalog will contain information on data characteristics, status, and location; and will be accessible to all IAS personnel. After test data files have been validated (e.g., it has been determined that they contain the desired characteristics), they will be stored in a common location to allow easy access by multiple groups (i.e., development, integration test, and system test). Some small test data files will be kept on-line to allow quick access. Larger files will be kept on tape and will be stored in CSC's Greentec IV facility in order to maintain configuration control.

5.3 Test Environments

This section describes the configuration of the integration and system test environments. A test environment consists of hardware elements, system software and COTS products including the operating system, Oracle application, and interface software not part of the IAS application software.

5.3.1 Setup and Verification

The test groups, with the support of the System Engineering and System Administration staff, will be responsible for the identification, setup, and verification of their respective test environments.

CM will be responsible for documenting each test environment (i.e., hardware elements and software versions) via a checklist audit prior to the start of a test period. The test environment is always a configured environment and changes to it must be documented and approved via a CCR.

5.3.2 Cleanup and Maintenance

After testing has been completed, the test environment must be prepared for the beginning of the next test phase.

- new regression data should be identified, cataloged and stored on tape
- all data, files, logs, messages, or mail that support test assessment or problem report analysis should be written to tape or hardcopy, marked with the appropriate reference, and stored
- all other (expendable) data files and log files should be purged from the test baseline
- the baseline database should be archived (by ORACLE tool)
- baseline IAS software should be backed up to tape, along with the database archive. The test group should maintain the current baseline and one previous; tapes from earlier baselines can be recycled

Maintenance of the test environment is the responsibility of the test group. Limitations on test resources may require environment cleanup to be done during the test phase. (i.e., releasing unnecessarily used disk space) to avoid impacts on test execution.

5.4 Software Turnovers

Upon successful completion of the development phase per release, the Project Configuration Review Board will determine if the software for a planned release or a software patch is ready to be promoted to the next phase of testing (i.e. integration test or system test). Once approval is granted an Electronic Software Change Notice will be prepared to transition the software to the next phase.

Upon the receipt of the Electronic Software Change Notice the IAS Configuration Management Assistant will promote the units to the appropriate test team, release the executables, install them in the test environment, and invoke the system. If each step is successful the system will be turned over to the appropriate test manager.

5.5 Delivery Packaging

The preparation of the delivery package is a team effort involving software development, system engineering, configuration management, integration and system test personnel. A Delivery Agreement Memorandum (DAM) approved by the SLA manager drives the contents (i.e., new development and CCRs) of the delivery. The

turnover packages (internal deliveries) from a given release become the delivery package draft, which is maintained by the CM group. Before the final document is produced, an internal delivery package review is held to ensure the completeness and accuracy of the contents.

Section 6 - Test Specifications -

All test sets for the IAS subsystem integration and system efforts are described in this section.

6.1 Subsystem Integration Test Sets

The following sections describe the test sets and cases planned for integrating the software subsystems of the IAS.

6.1.1 I&T Test Set 1 - Process Control Subsystem (PCS) -

Integration test set 1 tests the processing paths for managing the subsystems to process IAS mission operational tasks. This test set includes invocation by the user interface to initiate the processes to plan, monitor, calibrate and evaluate IAS subsystem operations.

The following test cases are planned for PCS integration testing:

01. To invoke RPS, GPS, and E&A subsystems without error.

02. To setup work orders for ingest of Level 1R and Level 1G processing.

03. To monitor progress of work orders.

04. To view system messages and alerts for intermediate action on halted work orders.

05. To successfully send processing parameters to the RPS subsystem without errors.

06. To successfully receive processing status from the RPS subsystem without error.

07. To successfully interface with the MOC for data acquisition without errors.

08. To successfully interface with the MOC to request concentrated Ephemeris without errors.

09. To successfully handle data availability notification from the DMS without errors.

10. To successfully send processing parameters to the GPS subsystem without errors.

11. To successfully receive processing status from the GPS subsystem without error.

12. To successfully send analyst notification when work orders have completed.

13. To successfully retrieve reports and files processed by the radiometric and geometric processing subsystems without errors.

6.1.2 I&T Test Set 2 - Geometric Processing Subsystem (GPS) -

Integration test set 2 tests the processing paths for Level 1G product generation, geometric calibration, geometric characterization for the Geometric Subsystem (GPS). This test set includes invocation to the Process Control Subsystem (PCS), Evaluation & Analysis Subsystem (E&A), Radiometry Processing Subsystem (RPS), and Data Management Subsystem (DMS).

The following test cases are planned for GPS integration testing:

01. To successfully receive work order parameters from PCS without errors.

02. To successfully send Status Errors to the PCS without errors.

03. To successfully make Level 1G status and 1G internal files available to the E&A subsystem without errors.

04. To successfully make calibration results available to the E&A subsystem without errors.

05. To successfully send characterization results to the E&A subsystem without errors.

06. To successfully send 1G Products to the DMS subsystem without errors.

6.1.3 I&T Test Set 3 - Evaluation & Analysis (E&A) Subsystem -

Integration test set 3 tests the processing paths for Evaluation & Analysis. This test set demonstrates the tools required by an IAS Analyst to evaluate and analyze ETM+ instrument performance, perform anomaly and maintain the Calibration Parameter File.

01. To successfully invoke application from radiometric and geometric subsystems without error.

02. Verify the capability to produce characterization and calibration report on level 0R, 1R and 1G products. The characterization should include reports on image files, PCD data file, and MSCD files.

03. Interactively construct and generate reports for annually, quarterly and monthly distribution to the EDC DAAC and MMO.

04. Verify the capability to generate statistical and trending information as a analyst.

05. Display images for visual inspection using operator selection map-projection coordinating system.

06. Verify the capability to perform “what if” type of scenarios (i.e.create a special L1G flow which creates multiple output images on different projections).

07. Display images of level 0R, 1R and 1G data products in color.

08. Print a scene in color. (if color printer available)

9. Verify the capability to produce plots from statistical results.

10. Verify the capability to create, update and submit work order for execution.

11. Verify the capability to invoke Environment for Visualizing Imagery (ENVI) to display images.

12. Verify that a user can view assessment progress and results.

13 Verify that a user can view alarms and alerts.

14 Verify that reports and summaries are available for retrieval from the database on demand.

6.1.4 I&T Test Set 4 - Data Management Subsystem (DMS) -

The Data Management Subsystem (DMS) is the application used to handle data request from all IAS subsystem. The following are the primary function of DMS and are used to develop interface test cases.

- notify IAS PCS of level OR product availability from the DAAC
- retrieve products from the DAAC on receipt of a Data Availability Notice (DAN)
- perform QC on image products and L0R files
- associate products with work orders
- manage data stores and retrievals
- monitor incoming file receipt and reformat data if necessary
- transfer files to external sources
- ingest FDF Ephemeris file
- archive data product files

01. Verify the IAS can specify a path to the Calibration Parameter File for EDC DAAC ingest process.

02. Verify the capability to send file transfer request to the MOC.

03. Verify DAN capability for the transfer of Calibration Parameter Files to the LPS without errors.

04. Verify the capability to ingest level 0R products from the DAAC

05. Verify that the Data Management Subsystem process correction to the Payload Correction Data (PCD) and Mirror Scan Correction data (MSCD) file upon receipt from the EDC DAAC.

06. Verify the capability to accept files pushed to designated directories.

07. Check the files pushed to the IAS without designated directories are not accepted.

08. Generate a request to retrieve a level 0R product via work order request.

09. Show that the system can be successfully shutdown on demand during a file transfer or file receipt but complete the in-progress file transfers.

10. To successfully interface with the LPS to send Calibration Parameter Files without errors.

11. To successfully ingest Level 0R products by the DMS without errors.

6.1.5 I&T Test Set 5 - Radiometric Processing Subsystem (RPS) -

The integration test set 5 tests the radiometric processing subsystem used to calibrate the in-flight radiance of each detector. This level 1R processing will convert the brightness of the image pixels to absolute radiance, and is completed prior to geometric processing.

01. To successfully invoke the Radiometric Subsystem via a work order control process.

02. To successfully produce calibration and level 1Rs (Scene) data.

03. To successfully produce updates to the Calibration Parameter File.

04. To successfully produce Radiometric Calibration statistics.

05. To successfully produce a radiometric corrected image.

6.2 System Test Sets

The following section describes the test sets and cases planned for system testing of the IAS. Because the test cases are grouped by logical sets, expected output and resources required to test are defined on the test set level. When required for clarification, details are included at the test case level.

6.2.1 System Test Set 1 - Work Order Control and Generation

Purpose: To ensure that an user can setup and edit requests for image assessment processing.

Description: This test defines the user ability to establish work orders used to ingest level 0R data products, perform “what IF” analysis, and request calibration and characterization for the radiometric and geometric processes.

Expected Output:

- Queue of Work Orders submitted
- Operator alarms on the console
- Payload Correction Data file from L0R ingest process
- Mirror Scan Correction Data file from L0R ingest process
- Image Data
- Calibration Parameter File
- Work Order Log
- All output files are correct and reside in the correct directory

Resources Required:

- Operator Interface
- Work Order Scheduler task
- Work Order Controller task
- Work Order Script task
- Radiometric Process Subsystem (RPS)
- Geometric Process Subsystem (GPS)
- Data Management Subsystem (DMS)
- Evaluation and Analysis Subsystem(E&A)
- Oracle Forms / DataBase

Test Method:

ES Req	Test Case	Test Description	Additional Results
3.2.1.1.1	1.01	Browse L0R products for orders from the DAAC.	
3.2.1.1.2 3.2.1.1.3	1.02	Setup a task work orders using a pre-defined oracle forms.	
3.2.1.1.2 3.2.1.1.3	1.03	Create a task work order using a pre-defined Oracle form for processing Level 0R data products from the DAAC	
3.2.2.6.1 3.2.2.6.4	1.04	Create a task work order using a pre-defined form for processing a Level 0R product through radiometric processing only.	
3.2.2.6.4	1.05	Review the status of any work order submitted for processing	
3.2.2.7.1 3.2.2.7.3 3.2.2.7.4 3.2.2.7.5 3.2.4.8	1.06	Setup task work orders which will allow the reporting of activites after level 1R, 1Rc or 1G processing	
3.2.1.1.2	1.07	Setup a work order that allows for automatic ingesting of Level 0R data during the year 2000.	
3.2.2.6.13	1.08	View alarms and alerts on all work orders processed.	
3.2.2.6.13	1.09	Selectively view alarms and alerts that required immediate action from the user.	
3.2.2.6.4	1.10	Verify that a created work order will allow a user to review the	

		current status.	
3.2.2.6.4	1.11	Create a work order using default parameters for all non mandatory fields.	
3.2.2.6.4	1.12	Create a request for a file transfer of the calibratin parameters files to the MOC.	
3.2.2..6.4	1.13	Create a work order which result in radiometric calibration only.	
3.2.2.6.4	1.14	Create a work order which will result in geometric processing only.	
3.2.2.6.1	1.15	Create a work order which will perform radiometric processing on Day Scene images.	
3.2.2.6.1	1.16	Create a work order which will perform radiometric processing on Night Scenes.	
3.2.2.6.1	1.17	Create a work order which will perform radiometric processing on MTF Scene	
3.2.2.6.1	1.18	Create a work order to request radiometric processing overriding random noise default parameters.	
3.2.2.6.1	1.19	Create a work order to request radiometric processing overriding default parameter for detector inoperability.	
3.2.2.6.1	1.20	Create a work order to request radiometric processing and overriding detector saturation parameter.	
3.2.2.6.1	1.21	Create a work order to request radiometric processing and override detector temperature.	
3.2.2.6.1 3.2.2.6.4	1.22	Modify any work order parameters before execution and verify the corrections were applied to the work order as specified.	
3.2.2.6.1 3.2.2.6.4	1.23	Create a procedure which includes multiple shell scripts that links work orders that defined a process for executinga,pausing and resuming the process.	
3.2.2.6.1	1.24	Create a work order to allow for a standard procedure that will be used pre-launch, that specify the standard sequence of radiometric and geometric applications to be executed for each IAS image file type.	
3.2.2.6.1	1.25	Create a work order which will result in radiometric processing using FASC data.	
3.2.2.6.1	1.26	Create a work order which will result in radiometric processing using PASC data.	
3.2.1.1.2	1.27	Setup a work order which allows ingesting and processing of data spanning the boundary from December 31, 1999 to January 1, 2000.	
3.2.1.1.2	1.28	Setup a work order which allows ingesting and processing of data spanning the boundary from February 28, 2000 to February 29, 2000 and ending on February 29, 2000.	
3.2.1.1.2	1.29	Setup a work order which allows ingesting and processing of data entirely within February 29, 2000.	
3.2.1.1.2	1.30	Setup a work order which allows ingesting and processing of data spanning the boundary from February 29, 2000 to March 1, 2000 and beginning on February 29, 2000.	
3.2.1.1.2	1.31	Setup a work order which allows ingesting and processing of data spanning the boundary from February 29, 2000 to March 1, 2000 and ending on March 1, 2000.	
3.2.1.1.2	1.32	Setup a work order which allows ingesting and processing of data spanning the boundary from December 30, 2000 to December 31, 2000 and ending on December 31, 2000.	
3.2.1.1.2	1.33	Setup a work order which allows ingesting and processing of data	

		spanning the boundary from December 31, 2000 to January 1, 2001 and beginning on December 31, 2000.	
3.2.1.1.2	1.34	Setup a work order which allows ingesting and processing of data entirely within December 31, 2000.	
3.2.1.1.2	1.35	Setup a work order which allows ingesting and processing of data spanning the boundary from December 31, 2000 to January 1, 2001 and ending on January 1, 2001	
3.2.1.1.2	1.36	Setup a work order which allows ingesting and processing of data beginning and ending in year 2001	
3.2.1.1.2	1.37	Verify that user input parameters are written to database and ASCII PVL file.	
3.2.4.14	1.38	Verify IAS operator's Graphic User Interface ("System ") capabilities.	
3.2.4.14	1.39	Verify IAS operator's Graphic User Interface ("work order") capabilities	
3.2.4.14	1.40	Verify IAS operator's Graphic User Interface ("request files") capabilities	
3.2.4.14	1.41	Verify IAS operator's Graphic User Interface ("Cal Parm File") capabilities	
3.2.4.14	1.42	Verify IAS operator's Graphic User Interface ("Monitor ") capabilities.	

6.2.2 System Test Set 2 - System Monitoring and Data Management

Purpose: To ensure that the user can monitor the operational process and provide operational control.

Description: This test set verifies that the IAS provides display and messages to indicate progress and status of software. The IAS operator can start up the software, change certain configuration parameters, override automated functions, and display statistical information.

Expected Output:

- Information Messages
- Alarm Messages
- Operator can override priority of work order
- Operator can request Bypass of certain process

Resources Required:

- Operator Interface
- Work Order Scheduler
- Evaluation & Analysis Software
- Radiometric Processing Subsystem
- Geometric Processing Subsystem
- Data Management Subsystem (DMS)

Test Method:

ES Req	Test Case	Test Description	Additional Results
3.2.2.6.3 3.2.2.6.8	2.00	Verify selected data parameters, and ancillary data are stored.	
3.2.2.6.4	2.01	Startup the IAS subsystem.	
3.2.2.6.4	2.02	Monitor automatic data receipt, from startup to termination.	
3.2.2.6.4	2.03	Change work order and monitor the process status.	
3.2.2.6.4	2.04	Monitor work order script processing and controls.	
3.2.2.6.4	2.05	Verify and review file transfer statistics.	
3.2.2.6.4 3.2.2.6.6	2.06	Verify analyst capability to select and store selected DEM.	
3.2.2.6.4 3.2.2.6.5	2.07	Verify analyst capability to select and store selected GCP and GCP chips.	
3.2.2.6.4	2.08	Review and monitor work order processing status.	
3.2.2.6.12	2.09	Monitor processing for PCD and mirror scan quality and verify threshold will not terminate processing.	
3.2.2.6.12	2.10	Monitor processing for level 0R data and verify thresholds will not terminate processing	
3.2.2.6.12 3.2.2.6.13	2.11	Select thresholds and monitor messages and alerts.	
3.2.2.6.4	2.12	Manually delete files.	
3.2.2.6.4	2.13	Cancel Work order.	
3.2.2.6.4	2.14	Verify that ASCII history files are maintained for each work order listing the steps executed.	

6.2.3 System Test Set 3 - Data Transfer to External Interfaces

Purpose: To ensure that the IAS can send reports and data files to the EDC DAAC, LPS and MOC.

Description: This test demonstrates the capability to transfer Calibration Parameter files, reports and assessments to the MOC, LPS and the EDC DAAC quarterly or as requested. For file transfer with errors, a manually intervention procedure will needed to be implemented to complete the successful transfer of data files to the site. The data transfer is accomplished through the use of a interactive network transfer process.

Expected Output:

- Data transfers through the DMS subsystem to external interfaces (EDC DAAC, LPS, MOC).
- Operator alarms on the console
- Calibration Scene Requests
- Calibration Parameter File
- Transfer problems are resolved by operator intervention

- All output files are correct and reside in the correct directory

Resources Required:

- Operator Interface
- Data Management Subsystem (DMS)
- TCP Session

Test Method:

ES Req	Test Case	Test Description	Additional Results
3.2.1.1.4 3.2.1.2.4 3.2.1.3.5	3.01	Transfer a Calibration Parameter File to the Mission Operation Center (MOC), LPS and DAAC automatically.	
3.2.1.1.3 3.2.1.3.4	3.02	Send IAS reports to the DAAC and MOC.	
3.2.1.3.3 3.2.1.3.1 3.2.1.3.2	3.03	Send a request to the MOC for concentrated definitive Ephemeris and operational acquisition of surface image data.	
3.2.1.1.2 3.2.1.2.1 3.2.2.6.4	3.04	Shutdown the system during file transfer and verify the transfer continues until all requests in the work order are satisfied.	
3.2.1.1.2 3.2.1.2.1 3.2.2.6.4	3.05	Startup of system will automatically restart file transfer for requests that were suspended during the shutdown.	
3.2.2.6.13	3.06	Verify an error message when attempting to handle a invalid file name specified by a work order.	
3.2.2.6.4	3.07	Verify the MOC receives the correct reports, files or request data.	

6.2.4 System Test Set 4 - Data receipt from External Interfaces

Purpose: To ensure that the IAS can retrieve reports and data files from external interfaces and store the data on a permanent media for later retrieval.

Description: This test demonstrates the capability to receive Level 0R data products, reports and assessments from the MOC, and DAAC. The test verifies that data capture begins accordance to a operator or work order request.

Expected Output:

- Automatically start data receipt and store the data products in temporary directory before permanent file assignments.
- Data transferred through the EDC DAAC interface and IAS DMS subsystem
- The equivalent of 10 ETM+ scene of data products can be received over a 24 hours period
- Data received remains unchanged during data transfer.

- Data Management Subsystem receives data without terminate until complete data receipt or manual end of process.
- Operator alarms on the console
- Transfer problems are resolved by operator intervention
- All output files are correct and reside in the correct directory

Resources Required:

- Operator Interface
- Data Management Subsystem (DMS)
- TCP Session

Test Method:

ES Req	Test Case	Test Description	Additional Results
3.2.2.6.4	4.01	Verify a directory is created when a DAN is received to ingest data products.	
3.2.2.6.4	4.02	Verify that files associated with receipt of a DAN are received into the correct directory.	
3.2.2.4.12 3.2.2.6.4	4.03	Verify that image products ingested are validated for the quality of the data.	
3.2.2.4.12	4.04	Verify that L0R product receipt is associated with the correct work order.	
3.2.1.1.2	4.05	Verify level 0R products are ingested from the DAAC.	
3.2.3.15	4.06	Receive at least 10 Level 0R scene products over a 24 hour period .	
3.2.2.6.3 3.2.2.6.4	4.07	Verify that all product received during a data transfer from a external interfaces are stored onto a permanent file.	
3.2.2.6.4	4.08	Verify that the receipt of a DAN will automatically and timely start the process to receive the data products.	
3.2.3.20 3.2.3.21 3.2.3.22	4.09	Verify that ingesting of any product will not exceed the maximum on-line storage capability.	
3.2.2.6.4 3.2.2.6.13	4.10	Verify an error message when transfer files will exceed the disk threshold.	

6.2.5 System Test Set 5 - Radiometric Calibration

Purpose: To ensure that the IAS can perform radiometric calibration and level 1R processing.

Description: This test process radiometric calibration functions to determine the in-flight calibration of each detector. The level 1 process converts the brightness of the image pixels to absolute radiance. This process uses various ground and in-flight determined calibations.. The level 1R characterize various features of the data.

Expected Output:

- Operator alarms on the console
- Trending Reports
- Calibration Scene Requests
- Calibration Parameter File
- Work Order Error Log
- Transfer problems are resolved by operator intervention
- All output files are correct and reside in the correct directory

Resources Required:

- Operator Interface
- Work Order Scheduler task
- Work Order Controller task
- Work Order Script task
- Radiometric Processing Subsystem(RPS)
- Data Management Subsystem (DMS)
- Evaluation & Analysis Subsystem (E&A)

Test Method:

ES Req	Test Case	Test Description	Additional Results
3.2.2.1.1 3.2.2.1.8 3.2.2.1.5	5.01	Verify that corrected estimates (Gains & Bias) are produced for the reflected bands of each ETM+ channel during radiometric processing	
3.2.2.3.2 3.2.2.1.8	5.02	Verify that during radiometric processing the new corrected coefficients are applied to each detector for producing level 1R data.	
3.2.1.2 3.2.2.1.8	5.03	Generate radiance's, biases and pulse levels from the level 0R requested images using the Partial Aperture Solar Calibration (PASC) data for all bands except band 6.	
3.2.2.1.3 3.2.2.1.8	5.04	Generate radiance's responses, biases and pulse levels from the level 0R requested images using the Full Aperture Solar Calibration (FASC) data for all bands except band 6.	
3.2.2.3.1 3.2.2.1.8 3.2.2.1.5	5.05	Generate radiance's responses, biases and pulse levels from the level 0R requested images using the Full Aperture Solar Calibration (FASC) data and specifying Ephemeris and vehicle attitude.	
3.2.2.3.1 3.2.2.1.8 3.2.2.1.5	5.06	Generate a level 1R corrected image and verify that the repeated process produces the same results using various radiometric data sources(PASC, FASC, Ephemeris, vehicle attitude ....).	
3.2.2.3.7 3.2.2.3.2 3.2.2.6.1	5.07	Generate and verify that calibration coefficients are produced using Ground look measurement from various target sites.	
3.2.2.3.7 3.2.2.3.2 3.2.2.1.8	5.08	Generate and verify that calibration coefficients are produced from PASC data sets in either high or low gain settings.	

3.2.2.1.5 3.2.2.6.1			
3.2.2.3.7 3.2.2.3.2 3.2.2.1.8 3.2.2.1.5 3.2.2.6.1	5.09	Generate and verify that gain ratios are produced when processing level 0R requested data through level 1R radiometric correction from PASC data sets in either high or low gain settings.	
3.2.2.3.7 3.2.2.3.2 3.2.2.6.1	5.10	Generate and verify that gain ratios are produced when processing level 0R requested data through level 1R radiometric correction from FASC data sets in either high or low gain settings.	
3.2.2.1.7 3.2.2.6.1	5.11	Generate and verify that the weighted estimates of gains for each detector in each band using results from PASC, FASC, Ground Look and High/Low Gain Ratio.	
3.2.2.6.13	5.12	Verify that level 1R processing will properly generate errors and alarm message after exceeding a targeted thresholds	
3.2.2.3.13 3.2.2.4.1 3.2.2.1.6	5.13	Verify that the level 1R radiometric process will produce and send results to the trending database, gains and biases which will be used to determine if the calibation file needs updating.	
3.2.2.6.1	5.14	Verify that gains and biases that equalize the histograms for all dectors within a band can be produced.	
3.2.2.6.1	5.15	Verify that estimation results (gain estimates, IC radiance esimates) are produced after level 1R processing.	
3.2.2.1.4 3.2.2.6.1 3.2.2.7.3	5.16	Verify that the 1R process produces AT-aperture radiances to be used for ground look analysis.	
3.2.4.8 3.2.2.4.12 3.2.2.1.6	5.17	Verify that Full aperture progress results (Pulse levels, detector response, and biases) are produced for review after Level 1R processing and before Geometry processing.	
3.2.2.4.13 3.2.2.1.6	5.18	Verify that the 1R process produces data (band to band ratios)to be used in trending.	
3.2.2.3.13	5.19	Verify that the characterization from a inoperable detector will produce trending data that can be used in determing the detector's anomalous performance (Quantized digital number (DN) < 50%.	
3.2.2.4.16	5.20	Generate and verify level 1R data using level 0R data that represents a sharp or straight line to evaluate the Modulation Transfer Function (MTF).	
3.2.2.4.16	5.21	Generate and verify that producing Level 1R data will result in determining the striping within a band for detector to detector.	
3.2.2.4.16 3.2.2.4.5	5.22	Generate Level 1R data that will result in determing the Signal to Noise Ratio (SNR) . Verify that the SNR is used in the process of developing trending analysis.	
3.2.2.4.12	5.23	To successfully invoke the Radiometric Subsystem for producing IRc (Calibration) and Level 1Rs (Scene) data on a database for Geometric Processing Subsystem.	
3.2.2.1.8	5.24	Verify the Radiometric processes to produce updates to the Calibration Parameter File.	
3.2.2.11 3.2.2.1.9	5.25	Verify that the radiometric calibration process uses level 0R data from the internal calibration for each ETM+.	
3.2.2.4.13 3.2.2.4.17	5.26	Verify that SCS for each scan state is stored in a trending database (day or night).	
3.2.2.1.5	5.27	Verify the SCS states(+1high state or -1 low state)for each scan of the instruments.	

3.2.2.4.13 3.2.2.4.17	5.28	Verify for one detector there magnitude and standard error is measured and stored in a SCS trending database (night scene with lamp off).	
3.2.2.4.13 3.2.2.4.17	5.29	Verify the SCS transition location process using 0R data, can be used to predict SCS location from start of scan, by scan line for each detector.	
3.2.2.4.13 3.2.2.4.17	5.30	Verify that SCS transition location can be validated through use of the SCS trending database time series analysis.	
3.2.2.4.12	5.31	Verify that the IAS dropped line characteristics are consistent with LPS dropped line statistics.	
3.2.2.4.12	5.32	Verify the location of high and low A/D saturated minor frames can be used to determine if certain detectors are prone to saturation.	
3.2.2.4.12	5.33	Verify the identification of saturated pixels (0 = low & 255 = hi) at the 0R level of processing are correctly characterized.	
3.2.2.4.12	5.34	Verify the identification of saturated pixels (0 = low & 255 = hi) at the 0Rc level of processing are correctly characterized.	
3.2.2.4.3 3.2.2.7.3	5.35	Verify that characterized random noise is used to generated to an output data base (calibrated sutter data FASC, night, and others) file for trending.	
3.2.2.3.13 3.2.2.4.3	5.36	Verify the output from random noise characterization can be used to detect degraded or inoperable detectors.	
3.2.4.14 3.2.2.6.10	5.37	Verify that histogram analysis process can be used to process level 0R,0Rc and 1R data to generate gains & biases of a detector (s).	
3.2.2.4.3 3.2.2.6.10	5.38	Generate histogram by detector and bands for number of excluded high and low pixels	
3.2.2.4.3 3.2.2.6.10	5.39	Generate histogram by detector and bands for number of pixels used in calculation	
3.2.2.4.3 3.2.2.6.10	5.40	Generate histogram by detector and bands to compute relative gains, biases and their differences for forward to reverse scans.	
3.2.2.4.3 3.2.2.6.10	5.41	Verify that a histogram can be used to evaluate processed scenes (1R) (i.e F.A.S.C) for residual striping.	
3.2.2.1.5	5.42	From the thermal band, verify that gains an offset by scene and scan are generated for each detector for CRaM and level 1 processing.	
3.2.2.7.1	5.43	Generate a report that allows an analyst to evaluate gain by scene and offset by scan for each detector.	
6.2.2.7.1	5.44	Generate a report that allows an analyst to evaluate scene and not offset for each detector, for each gain state.	
3.2.2.7.1	5.45	Generate a report that allows an analyst to evaluate uncertainty in offsets.	
3.2.2.1.1 3.2.2.7.1 3.2.2.7.4	5.46	Verify that the calibration of onbound internal calibration rejects shutter data points containing errors.	
3.2.2.1.1 3.2.2.7.1 3.2.2.7.4	5.47	Verify that the calibration of onbound internal calibration rejects lamp data points containing transmission errors.	
3.2.2.1.1 3.2.2.4.13	5.48	Verify that the calibration of onbound internal calibration,reports detector gains, bias, lamp statistics,net pulse values and integrated shutter values to a trending database.	
3.2.2.1.1	5.49	Verify that the calibration of onbound internal calibration uses integrated shutter valus to calculate detector bias.	
3.2.2.1.1	5.50	Verify that the calibration of on bound internal calibration uses lamp pulses valus to calculate detector gains(all bands except band 6)	
3.2.2.1.5	5.51	Verify the prelaunch data for reflective bands is used to detemine the	

		absolute gains (biases) for each detector for each gain state.	
3.2.2.1.5 3.2.2.4.13	5.52	Verify that the absolute gains for each reflective band detector for each gain state is reported on the trending database.	
3.2.2.1.1 3.2.2.1.2 3.2.2.1.5 3.2.2.1.7	5.53	Verify that the combined radiometric model (CRAM) integrates the results from various calibration sources(IC,FASC,PASC,GLC and prelaunch data)	

6.2.6 System Test Set 6 - Geometric Processing

Purpose: To ensure that imagery from Level OR data products are geometrically corrected.

Description: This test defines the IAS and user capabilities to establish and maintain functionality required for Level 1G product generation for geometric calibration, geometric characterization and evaluation.

Expected Output:

- Status Error's
- 1G Internal File
- Metadata Report
- ETM+ Model
- Attitude Statistics
- Scan Gap Statistics
- 1Gs Image
- 1Gp Image
- 1Gt Image
- Data Descriptor Record (DDR)
- Off-Nadir Elevation Pixel Offsets
- Operator alarms on the console

Resources Required:

- Operator Interface
- Work Order Controller Task
- Work Order Script Task
- Work Order Scheduler Task

Test Method:
Functional tests verified by analysis and inspection.

6.2.6.1 System Test Set 6.1 - Level 1 G Processing

ES Req	Test	Test Description	Additional

	Case		Results
3.2.2.3.1	6.1.01	Verify that payload correction data (PCD) and MSCD is processed for spacecraft time, attitude and jitter, Ephemeris correction.	
3.2.2.3.3 3.2.2.3.5	6.1.02	Verify that the process flow generates systematically corrected, precision corrected and terrain corrected products using GCPs and DEMs appropriately.	
3.2.2.3.8	6.1.03	Verify modulation transfer function (MTF) evaluation resampling, compensation, nearest neighbor or cubie convolution resampling is performed on 1G imagery. (i.e. highways, bridges)	
3.2.2.3.7	6.1.04	Verify calibration coefficient are in Level 1 data generation.	
3.2.2.3.9	6.1.05	Verify that the system can produce geometrically corrected data with sampling interval specified. Case 1 2 3 4 Pan 12.5 15 MS 25 30 Thermal25 30 50 60	
3.2.2.3.10	6.1.06	Generate 1G in imagery Space Oblique Mercator (SOM).	
3.2.2.3.12	6.1.07	Verify that MSCD is processed for scan start time, mid scan interval, and SLC correction	
3.2.2.6.13	6.1.08	Generate and verify messages and alarms to alert the operator to results and errors that exceed selected thresholds.	
3.2.2.3.15	6.1.09	Verify that the system produces correct 1G and 1R products from an ascending or descending node data.	
3.2.2.3.1	6.1.10	Verify the time corrected PCD and MSCD from 0R products are used to generate a ETM+ model (ASCII). (1G-TMINT).	
3.2.2.3.1	6.1.11	Verify the time corrected PCD and MSCD from 0R products are used to generate attitude data (trending output). (1G-TMINT).	
3.2.2.3.1	6.1.12	Verify that CPF and metadata from 0R products are used to generate metadata report files. (1G-TMINT).	
3.2.2.3.3 3.2.2.3.4	6.1.13	Verify that the ETM+ model file has been used to create grid of points in input (1R) image space to generate corresponding output (1G) image space location (1G-TMGRID).	
3.2.3.12	6.1.14	Verify the ability to use GCPs to mark positions in the image and thereby determine geographic location accuracy.	

6.2.6.2 System Test Set 6.2 - Calibration

ES Req	Test Case	Test Description	Additional Results
3.2.2.2.1	6.2.01	Verify the capability to perform sensor alignment calibrations	
3.2.2.2.2 3.2.2.2.3 3.2.4.8	6.2.02	Verify that the tools for adjusting band-to-band offset corrections are available.	
3.2.2.2.4	6.2.03	Generate and verify geometric calibration updates for approved geometric processing parameters supplied to the DAAC.	
3.2.2.10	6.2.04	Verify that geometric processing parameters are produced in the form of adjusted alignment angles.	
3.2.2.6.13	6.2.05	Generate and verify messages and alarms to alert the operator to	

		results and errors that exceed selected thresholds.	
3.2.2.2.4 3.2.2.34	6.2.06	Verify that level 1G process has been used to update the GCP library file statistics. level 1G-GCP corrected	
3.2.2.2.3 3.2.2.2.4 3.2.2.4.17	6.2.07	Verify the capability to perform mirror calibration to verify 1G image is corrected with non ETM+ reference image.	
3.2.2.2.3 3.2.2.2.4 3.2.2.4.17	6.2.08	Verify that the results of mirror calibration process is repeated in the trending database, CPF mirror profile file, and mirror calibration report file (ASCII).	
3.2.2.2.2 3.2.2.2.4 3.2.2.4.10 3.2.2.4.17	6.2.09	Verify that the results of band to band registration assessment is used to identify the CPF best fit band center locations	
3.2.2.2.2 3.2.2.2.4 3.2.2.4.10 3.2.2.4.17	6.2.10	Verify that the results from band calibration is reported into a report file, trending database and CPF band location database	
3.2.2.2.4	6.2.11	Verify the ability to use GCPs to mark positions in the image and thereby determine geographic location accuracy.	

6.2.6.3 System Test Set 6.3 - Characterization

ES Req	Test Case	Test Description	Additional Results
3.2.2.3.6 3.2.2.4.11	6.3.01	Verify 2 scene of the same WRS for accuracy on the image to image registration of common bands of temporally distint ETM+ Level 1G	
3.2.2.4.10 3.2.3.7 3.2.3.11	6.3.02	Verify the numerical evaluation of accuracy on band-to-band registration of each ETM+ band to all other bands within a single all-bands Level 1G image	
3.2.2.4.8 3.2.2.4.9	6.3.03	Verify the geodetic, internal geometric accuracy of ETM+ 1G image data.	
3.2.3.9	6.3.04	Verify that circular errors no greater than 3.6m, 1 sigma, during image to image registration correction of ETM+ Level 1G data.	
3.2.2.6.13	6.3.05	Generate and verify messages and alarms to alert the operator to results and errors that exceed selected thresholds.	
3.2.4.14	6.3.06	Verify IAS Analyst's Graphic User Interface menu("Operator Functions") capabilities.	
3.2.4.14	6.3.07	Verify IAS Analyst's Graphic User Interface menu ("Image Analysis") capabilities.	
3.2.4.14	6.3.08	Verify IAS Analyst's Graphic User Interface menu ("IAS applications") capabilities.	
3.2.4.14	6.3.09	Verify IAS Analyst's Graphic User Interface menu ("Trending Analysis") capabilities.	
3.2.4.14	6.3.10	Verify IAS Analyst's Graphic User Interface menu ("Quarterly Reports") capabilities.	

6.2.7 System Test Set 7 - Accuracy

REVIEW

Purpose: To ensure the mathematical accuracy is consistent with the visual assessments of Level 1G images. Also, to ensure the computational accuracy is within allowed specification

Description: This test set verifies the accuracy of various sub-functions (Geometric , radiometric, image to image registration and etc.) errors in the process evaluation and visual assessment.

Expected Output:

- Status Error's
- 1G Internal File
- radiometric calibration results
- Trending Reports
- Metadata Report
- ETM+ Model
- Attitude Statistics
- Scan Gap Statistics
- 1Gs Image
- 1Gp Image
- 1Gt Image
- Off-Nadir Elevation Pixel Offsets
- Operator alarms on the console

Resources Required:

- Operator Interface
- Work Order Controller Task
- Work Order Script Task
- Work Order Scheduler Task
- Radiometric Processing Subsystem(RPS)
- Data Management Subsystem (DMS)
- Evaluation & Analysis Subsystem (E&A)

Test Method:

ES Req	Test Case	Test Description	Additional Results
3.2.3.1	7.01	Verify the radiometric response (absolute spectral radiance) of each operable ETM+ detector to an accuracy of 5 percent, 1 sigma, providing all inputs are within specification.	Not testable as written need ground truth data.
3.2.3.2	7.02	Verify the relative radiometric response such that the ratio of ETM+ equivalent at-aperture radiance is between any combination of two spectral bands, excluding band 6, shall vary less than 2 percent, 1 sigma, over a 7-day period when exposed to a	

		spectrally constant source.	
3.2.3.3	7.03	Verify that the radiometric processing contribute no greater than 0.7 percent uncertainty to absolute radiometric accuracy during the generation of Level 1R and 1G data.	
3.2.3.4	7.04	Create systematic imagery to a geodetic accuracy of 250 meters, 1 sigma, providing all inputs are within specification. Performance applies to along-track and cross-track directions and is referenced to a nadir-viewing geometry.	
3.2.3.5	7.05	Verify circular errors no greater than 1.8 meters, 1 sigma, in the production of systematically corrected ETM+ Level 1G imagery. This error is referenced to a nadir-viewing geometry and excludes the effect of terrain correction.	Not testable as written, need post launch data.
3.2.3.6	7.06	Verify the overlap of 2 Bands with different resolution for common scenes to an accuracy of 0.28 sensor GSD, 0.9p, in along-track and cross-track directions.	
3.2.3.7	7.07	Verify that the Level 1G process contribute errors no greater than 0.11 multispectral sensor GSD, 0.9p, along-track, and 0.24 multispectral sensor GSD, 0.9p, cross-track in the assessment of band-to-band registration.	Analysis only
3.2.3.8	7.08	Verify image-to-image registration to an accuracy of 0.4 multispectral sensor GSD, 0.9p, in the along-track and cross-track directions providing all inputs are within specification.	Need flight data to verify this test case.
3.2.3.9	7.09	Verify circular errors no greater than 3.6 meters, 1 sigma, during image-to-image registration correction of ETM+ Level 1G data. Error is referenced to a nadir-viewing geometry and excludes the effect of terrain correction.	Need flight data to verify this test case.
3.2.3.10	7.10	Estimating the field angles for the spacecraft attitude control system to an accuracy of 0.18 arcsec, 1 sigma.	Need clarification of this requirement
3.2.3.11	7.11	Verify that digitally correlating common features in separate bands of the same image or same bands of separate images to an accuracy of 0.1 pixel, 0.9p.	Analysis only
3.2.3.12	7.12	The IAS shall be capable of estimating the alignment of the ETM+ line-of-sight to the satellite navigation base reference to an accuracy of 24 arcsec, 1 sigma, in all axes.	Need post launch data to validate test case.

6.2.8 System Test Sets 8 - Reports

Purpose: To ensure that the IAS can generate reports and data files for assessments and analysis.

Description: This test demonstrates the capability to generate reports and assessments The test verifies that data capture during the major processes are accurate and reflected in the reports as requested.

Expected Output:

- Reports contain all data required as expected
- User can request report for display
- User can request reports for printers

Resources Required:

- Work Order task
- Operator interface display
- Evaluation and Analysis subsystem (E&A)
- Radiometric Processing Subsystem(RPS)
- Geometric Processing Subsystem(GPS)

Test Method:

ES Req	Test Case	Test Description	Additional Results
3.2.4.8	8.01	Generate a report that characterize Data Quality for Impulse noise from Level 0R data.	
3.2.2.4.12	8.02	Generate a report that characterize dropped lines.	
3.2.2.7.1 3.2.2.7.4 3.2.2.7.5	8.03	Generate a report that characterize memory effects	
3.2.2.3.14 3.2.2.4.3 3.2.2.7.5	8.04	Generate a report that characterized Scan Correlated shifts.	
3.2.2.4.3 3.2.2.7.5	8.05	Generate a report that characterize Coherent Noise.	
3.2.2.7.1 3.2.2.7.5	8.06	Generate a report that characterize Detector Saturation.	
3.2.2.4.4 3.2.2.7.5	8.07	Generate a report that characterize MTF.	
3.2.2.4.3 3.2.2.7.5	8.08	Generate a report that characterize Random Noise.	
3.2.2.7.1	8.09	Generate a histogram to show pictorial characterize Banding	
3.2.2.4.3 3.2.2.7.5	8.10	Generate a report that characterize Striping and Banding.	
3.2.2.4.8 3.2.2.7.5 3.2.3.17	8.11	Generate a report that will characterize the Geodetic accuracy on a quarterly basis.	
3.2.2.4.8 3.2.2.7.5	8.12	Generate a report that will characterize the Geometric accuracy on a quarterly basis.	
3.2.2.4.8 3.2.3.17 3.2.2.7.5	8.13	Generate a report that characterize Band to Band registration accuracy on a quarterly basis.	
3.2.2.4.8 3.2.2.7.5 3.2.3.17	8.14	Generate a report that characterize Image to Image registration accuracy on a quarterly basis.	
3.2.2.4.8 3.2.3.17 3.2.2.7.1	8.15	Generate a report that allows an analyst to evaluate LPS data quality on a periodically basis (Monthly / Annually)	

3.2.2.4.8 3.2.3.17 3.2.2.7.1	8.16	Generate a report that allows a analyst to evaluate Level 1R data quality on a periodically basis (Monthly / Annually)	
3.2.2.4.8 3.2.2.4.12 3.2.3.17 3.2.2.7.5	8.17	Generate reports that allows a analyst to evaluate Level 0R data and products daily.	
3.2.2.4.8 3.2.3.17 3.2.2.7.1	8.18	Generate a report that allows a analyst to evaluate PCD quality on a periodically basis (Monthly / Annually)	
3.2.2.4.8 3.2.3.17 3.2.2.7.1 3.2.3.19	8.19	Generate selected trend reports that allows an analyst to evaluate data capture, radiometric, geometric and other processes.	

6.3 System Integration Test Set

Purpose: System Integration Tests are intended to verify the IAS as an operational system. Interfaces with the MOC, EDC DAAC, and LPS are intended to be run with the hardware and software of the actual facilities.

6.3.1 System Integration Test Set 1- Operational Scenarios and Procedures

ES Req	Test Case	Test Description	Additional Results
3.2.4.9 3.2.2.5.4	S1.00	Setup/Install IAS operational software on the operational system.	
3.2.4.10 3.2.2.5.4	S1.01	Setup/Install IAS operational software on the test system while IAS operational system is in place..	
3.2.2.5.1 3.2.2.5.2 3.2.2.5.4	S1.02	Perform maintenance on the test system without impacting the operational system.	
3.2.2.6.11 3.2.2.6.9 3.2.3.16	S1.03	Archive operational software and data without impacting operations to tape.	
3.2.2.6.11 3.2.2.6.9 3.2.3.16	S1.04	Archive a maintenance version of the software from the test system to tape.	
3.2.2.4.16	S1.05	Startup IAS software on the test system.	
3.2.2.4.16	S1.06	Verify all required tasks were initiated.	
3.2.2.6.1	S1.07	Verify a browser is available for ordering data from the DAAC.	
3.2.2.6.1	S1.08	Setup a Work Order form to request a scene from the DAAC by orbit number and WRS path/row.	
3.2.4.2	S1.08	Print Work Order request form.	
3.2.4.3	S1.09	Submit Work Order request and verify the work order queue.	
3.2.4.7	S1.10	Perform “what if” scenarios on the processed work order.	
3.2.4.9	S1.11	Evaluate processing results for accuracy and performance.	

3.2.4.10 3.2.2.2.4	S1.12	Generate a new calibration parameter file.	
3.2.4.11 3.2.2.7.5	S1.13	Generate radiometric calibrations accuracy and summary reports	
3.2.4.12 3.2.2.7.5 3.2.2.4.9	S1.14	Generate geometric calibration accuracy and summary reports	
3.2.4.13	S1.15	Generate PCD data quality report.	
3.2.4.14	S1.16	Generate Level 0R data quality report	
3.2.2.7.4	S1.17	Generate anomaly detection reports.	
3.2.2.7.3	S1.18	Generate calibration coefficient report.	
3.2.2.7.1 3.2.2.4.12	S1.17	Evaluate quality reports for accuracy.	
3.2.2.4.15	S1.18	Display scene image.	
3.2.2.4.17	S1.19	Print scene image.	
3.2.2.2.1 3.2.2.2.2 3.2.2.2.3	S1.20	Setup an perform “Multiwedge Collimator Test” to evaluate IAS calibration process..	

6.3.2 System Integration Test Set 2 - System Interfaces -

ES Req	Test Case	Test Description	Additional Results
3.2.1.2.4	S2.01	Send calibration parameter file to the LPS.	
3.2.1.3.5	S2.02	Send calibration parameter to the MOC.	
3.2.1.3.4	S2.03	Send problem reports file to the MOC.	
3.2.1.3.2	S2.04	Send MOC calibration requests for Enhanced Thematic Mapper Plus (ETM+) images.	
3.2.1.3.1	S2.05	Request full aperture calibrations ETM+ images from the MOC.	
3.2.1.3.1	S2.06	Request partial aperture calibrations ETM+ images from the MOC.	
3.2.1.3.2	S2.07	Request ground look calibration ETM+ images from the MOC.	
3.2.1.3.2	S2.08	Send IAS problem reports to the MOC.	
3.2.1.3.6	S2.09	Receive spacecraft status reports from the MOC.	
3.2.1.3.6	S2.10	Receive telemetry trending analysis reports from the MOC.	
3.2.1.3.7	S2.11	Receive definitive Ephemeris data from the MOC to IAS.	

Section 7 - Test Resource Requirements -

7.1 Test Environment

The following subsections describe the hardware and software configurations from which testing will be performed.

7.1.1 Hardware configuration

The system administrator will set up and configure all IAS hardware elements, including system software, for the test environment. Some tests may require access to hardware located at GSFC (e.g. tape drives) and consequently will be executed at GSFC. Each tester will require simultaneous access to a separate Xterminal.

7.1.2 Software configuration

Separate software environments will be established for each of the test groups. Executable software for each release will be located in separate directory structures and the individual test groups will be able to concurrently execute tests using the software in these directories. Each test group will also have a separate database instance. The development organization will provide a set of "suggested" initial values for all static database tables. These values will be changed by the test groups as necessary to conduct the tests. After the initial static values have been loaded, the contents of the database instances will be maintained by the individual test groups.

7.2 Test Tools

Test tools will be used wherever possible to automate and support the test effort. The following subsections describe details of the test tools that are planned.

7.2.1 Drivers and Stubs

A driver will be required to simulate transfer of data from the EDC DAAC and MOC. An simulator will be required to verify the Data Availability Notice (DAN) exchange process. This simulator will receive DANs, validate DANs, and return Data transfer acknowledgments. The simulator will have the capability to either automatically send a valid acknowledgment or to send a data transfer acknowledgment with predefined errors.

During integration testing, stubs and drivers will be required to simulate subsystems that have not yet been developed.

7.2.2 Data Dump and Analysis

The following data dump tools will be developed to assist in the analysis of test output:

Tool	Description
Calibration file dump	The calibration file dump tool will allow the user to choose whether a summary dump or a full dump is desired for a range of scan lines. If a summary dump is chosen, the tool will produce an ASCII formatted dump such that each line of

	the tool's output contains all of the calibration file information from a single scan except for the calibration data line (pixel data). The full dump option will follow each line of the summary dump with a hexadecimal dump of the image data.
MSCD file dump	The MSCD file dump tool will produce an ASCII formatted dump for a user-specified range of scan lines such that each line of the tool's output contains all of the MSCD file information from a single scan.
PCD file dump	The PCD file dump tool will produce an ASCII formatted dump for a user-specified range of PCD major frames. The user will be able to specify whether or not the PCD major frame data is to be included in the output.
Browse file dump	The browse file dump tool will generate a formatted ASCII dump of the text information associated with the browse file and a hexadecimal dump of the image data associated with the file.
Database table dump	The database dump tool will present the user with a list of the IAS database tables. The user will then be able to select which table to dump and whether all fields or a predetermined subset of the fields are desired. Alternatively, the user may execute a script that will dump the contents of each table into a file.

Metadata files will be in an ASCII ODL format that can be viewed by using the UNIX cat or more commands. No dump tool is needed.

The gtedit utility will be used to view hexadecimal dumps of trouble files. A comparator (e.g., UNIX diff program) will be used for regression tests to compare the output from the current release to that of previous releases.

7.2.3 Test Execution Scripts

UNIX shell scripts will be developed to: reinitialize the test environment (e.g., set database values back to a known starting point) combine frequently executed commands automate regression tests

7.2.4 Test Tool Design and Reuse

To the greatest extent possible, attempts will be made to reuse tools and scripts that already exist. Other MOSDD projects will be investigated to determine if any tools or scripts exist that can be reused. Additionally, all IAS tools and scripts that are either acquired or developed for use on the IAS will be placed in a common area so that they may be shared among all of the development and the test groups.

7.2.5 Test Tool Development, Verification and Configuration

Test tools will be developed by:

GTSIM:	Complete
EDC DAAC simulator	IAS development

HDF swath to HDF	IAS development
dump/analysis tools	IAS development/IAS system test
LPS simulator	LPS development
MOC simulator	IAS development/IAS system test

All test tools must be verified and placed under configuration control before testing begins for the release in which the tools will be used. This configuration control may be formal (i.e., the tools are placed into the project's configuration control system) or informal (i.e., changes to the tools are controlled by limiting write access to the executable files). Typically, tools that have been developed to dump data files or simulate external systems will be formally controlled, while test execution scripts will be informally controlled.

7.3 Test Data

The following subsections describe details of the data that are planned for testing the IAS.

List of Landsat 4/5 scenes to be run through GTSIM and converted to Landsat 7 raw format:

The scenes of Kansas City, Colorado Springs, and White Sands.

- Minnesota Path 28 Row 29
- Kansas City Path 30 Row 33
- Georgia Path 18 Rows 37 & 38
- California Path 39 Rows 36 & 37
- California Path 41 Rows 36 - Edwards Air Force Base (band to band)
- White Sands (specific scene with markers for radiometry)

The following group are scenes needed for testing but have not been completely defined

- Cloudy scene
- Snowy scene
- Land Use scene (e.g. Chugash, Alaska)
- Scenes with Coherent Noise
- Scenes with other radiometric artifacts (i.e. ME, SCS, banding)

7.3.1 Test Data Determination

Test data will be designed with several purposes in mind:

- to verify that the IAS correctly processes data containing the characteristics that are nominally received from the LGS
- to verify the functionality of the IAS software
- to stress the IAS data processing algorithms
- to verify that the IAS correctly processes data containing the errors that are most likely to occur during the mission's lifetime

Some test data of the nominal size will be required. Most will be smaller in order to allow for quicker generation, evaluation, and ease of storage.

7.3.2 Test Data Generation and Verification

The Generic Telemetry Simulator (GTSIM) (and its associated utility programs) will be used to generate simulated data in the format that will be received from the LGS. The current GTSIM hardware cannot support files larger than 2 GB. As test data files greater than 7 GB will be required for IAS verification, GTSIM will be ported to one of the IAS computers in order to perform generation of these large files. Before being used for IAS verification, each test data file will be examined to verify that it contains the expected test data characteristics.

Some error conditions will be introduced into the test data as it is generated by GTSIM, additional errors will be introduced after the data has been generated. The GTEDIT tool will be used to introduce individual bit errors into particular data records.

Any data that are received from prelaunch tests with the Landsat spacecraft, or interface tests with the LGS, will be saved and re-used for future testing of the IAS. Data from previous Landsat missions will be extracted from archive, attitude and ephemeris data will be converted to the Landsat 7 format, and the reformatted data will be inserted into the payload correction portion of the test data produced by GTSIM.

7.4 Personnel Resources

The following subsections describe details of the staff planned for testing the IAS and otherwise supporting the test teams.

7.4.1 Test Personnel

At the end of each development phase, a team will be assembled to perform the subsystem integration and testing. This team will be formed from the development, system engineering, and system test organizations.
System tests will typically be conducted by a team of three people. These people will perform the release test planning, test data and tool preparation, and test execution.
All test personnel will require skills in UNIXs ‘C ‘ and Oracle. Training will be required for personnel who do not already have the necessary experience.

7.4.2 Support Personnel

In order to write effective test procedures, test personnel will have to work closely with development personnel during the test planning phase for each release. The

developers will ensure that the testers fully understand how to operate the system and analyze test results before testing begins.

During each test execution phase, it is expected that a primary contact person will be designated from each of the following areas to support test problem resolution and facility scheduling:

- software development
- system engineering
- configuration management
- product assurance
- system administration
- IAS
- algorithm science team

7.5 Schedule Requirements

For each release, as module testing is completed for each subsystem, the subsystems will be promoted to the integration test environment. As each subsystem is added, tests will be conducted to integrate the new subsystem with the rest of the system. After all subsystems have been promoted to this level, a nominal 2 week integration test period will begin.

The system test execution phase will be conducted over a 2 month period, following successful completion of integration testing. The first few days are typically used to perform and verify the installation of software in the system test environment. Confidence test are executed to verify that the release was successful, and that the integration test and system test environments are configured correctly. At least one week before each official software turnover to System Test, an "engineering" version of the software will be made available to the system test team so that dry runs of the test procedures can be performed.

Section 8 IAS Traceability Matrix

IAS Traceability Matrix for IAS 3.2 Element Specifications

8.1 Interface Requirements

3.2 REQS	Test Case	REQUIREMENTS SUMMARY
3.2.1.1.1	1.01	The IAS shall interface with the EDC DAAC for purposes of searching for and ordering of data from theLandsat 7 archive.
3.2.1.1.2	1.02,1.03,1.07, 3.04,3.05	The IAS shall receive Level 0R data and Level 0R products and associated ancillary data from the EDC DAAC.
3.2.1.1.3	1.02, 1.03, 3.02	The IAS shall interface with the EDC DAAC to coordinate the transfer of calibration parameter files and IASgenerated reports.
3.2.1.1.4	3.01	The IAS shall send calibration parameter files and IAS-generated reports to the EDC DAAC.
3.2.1.2.1	3.04, 3.05	The IAS shall interface with the LPS to coordinate the transfer of calibration parameter files and reprocessing requests.
3.2.1.2.2	TBD	The IAS shall send reprocessing requests to the LPS.
3.2.1.2.3	TBD	The IAS shall receive disposition of reprocessing requests from the LPS.
3.2.1.2.4	3.01, S2.01	The IAS shall send calibration parameter files to the LPS.
3.2.1.3.1	3.03, S2.05, S2.06	The IAS shall send requests to the MOC for the operational acquisition of partial-aperture calibration data, full-aperture calibration data, and surface image data of radiometric and geometric calibration ground sites.
3.2.1.3.2	3.03, S2.04, S2.07, S2.08	The IAS shall coordinate with the MOC for the acquisition of ETM+ imagery required for calibration and image assessment, for transfer of calibration parameter files, and for transfer of problem reports.
3.2.1.3.3	3.03	The IAS shall send requests to the MOC for concentrated definitive ephemeris.
3.2.1.3.4	3.02	The IAS shall send problem reports to the MOC.
3.2.1.3.5	3.01, S2.02	The IAS shall send calibration parameter files to the MOC.
3.2.1.3.6	S2.09, S2.10	The IAS shall be capable of receiving trend reports, spacecraft status reports, and event schedules from the MOC.
3.2.1.3.7	S2.11	The IAS shall be capable of receiving FDFgenerated definitive ephemeris from the MOC.
3.2.1.4.1	TBD	The IAS shall send problem reports and summary reports to the MMO.

8.2 Radiometric Calibration

3.2 REQS	Test Case	REQUIREMENTS SUMMARY
3.2.2.1.1	5.01	The IAS shall be able to use data from the internal calibrator in the calibration of the radiometric response of each ETM+ detector.
3.2.2.1.2	5.03	The IAS shall be able to calibrate the radiometric response of each ETM+ detector, except band 6, using data from thePASC.

3.2 REQS	Test Case	REQUIREMENTS SUMMARY
3.2.2.1.3	5.04	The IAS shall be able to calibrate the radiometric response of each ETM+ detector, except band 6, using data from the FASC.
3.2.2.1.4	5.16	The IAS shall be able to calibrate the radiometric response of each ETM+ detector given Level 0R data of a ground calibration site and corresponding at-aperture spectral radiance values.
3.2.2.1.5	5.01, 5.05, 5.06, 5.08, 5.09	The IAS shall be able to calibrate the radiometric response of each ETM+ detector using Level 0R data from preship and prelaunch calibration sources and auxiliary calibration source data.
3.2.2.1.6	5.13, 5.17, 5.19	The IAS shall have the capability of assessing the short-term and long-term stability of the onboard calibration sources, which include the FASC, the PASC, and the internal calibrators.
3.2.2.1.7	5.11	The IAS shall be able to integrate the results of the various calibration processes into an optimal estimate of radiometric calibration of each detector (except band 6) and provide new calibration parameters.
3.2.2.1.8	5.01, 5.02, 5.03, 5.04, 5.05, 5.06, 5.08, 5.09, 5.26	The IAS shall be capable of generating radiometric calibration updates for the calibration parameter file.
3.2.2.1.9	5.27	The IAS shall be able to transfer the calibration of each detector to the internal calibrator.

8.3 Geometric Calibration

3.2 REQS	Test Case	REQUIREMENTS SUMMARY
3.2.2.2.1	6.2.01, S1.20	The IAS shall be capable of determining the misalignment between the satellite navigational base reference and the ETM+ payload LOS.
3.2.2.2.2	6.2.02, S1.20	The IAS shall be capable of determining band-to-band registration parameters.
3.2.2.2.3	6.2.02, S1.20	The IAS shall be capable of characterizing and updating along and across scan parameters (i.e., scan mirror profiles, scan corrected mirror profile, detector offsets, detector delays).
3.2.2.2.4	6.2.03, S1.12	The IAS shall be capable of generating geometric calibration updates for the calibration parameter file.

8.4 Level 1 Processing

3.2 REQS	Test Case	REQUIREMENTS SUMMARY
3.2.2.3.1	5.05, 5.06, 6.1.01	The IAS shall be capable of processing PCD data to correct spacecraft time, generate sensor pointing model (attitude and jitter), and calculate spacecraft position and velocity (ephemeris).
3.2.2.3.2	5.02, 5.07, 5.08, 5.09, 5.10 6.1.02	The IAS shall be capable of processing ETM+ Level 0R products to produce radiometrically corrected Level 1R image data.
3.2.2.3.3	6.1.03	The IAS shall be capable of creating systematically corrected ETM+ Level 1G imagery from Level 0R products.
3.2.2.3.4	6.1.03	The IAS shall be capable of creating precision corrected ETM+ Level 1G imagery from Level 0R products and GCPs.
3.2.2.3.5	6.1.03	The IAS shall be capable of creating terrain corrected ETM+ Level 1G imagery from Level 0R products, GCPs, and elevation data.
3.2.2.3.6	6.3.01	The IAS shall be capable of performing image-to-image registration.

3.2 REQS	Test Case	REQUIREMENTS SUMMARY
3.2.2.3.7	5.07, 5.08, 5.09, 5.10, 6.1.05	The IAS shall be capable of incorporating IAS-generated calibration coefficient updates to generate Level 1 data.
3.2.2.3.8	6.1.04	The IAS shall support nearest neighbor, cubic convolution, and MTF compensation resampling.
3.2.2.3.9	7.09, 6.1.06	The IAS shall have the capability to produce a 1G product with a grid cell size that is variable from 15 to 60 meters, in increments of 1 mm.
3.2.2.3.10	7.10, 6.2.04, 6.1.07	The IAS shall have the capability to map project 1G using the Space Oblique Mercator, Universal Transverse Mercator, Lambert Conformal Conic, Transverse Mercator, Oblique Mercator, and Polyconic coordinate reference systems.
3.2.2.3.11	7.11	The IAS shall have the capability to create a 1G image oriented to nominal path or north-up.
3.2.2.3.12		Deleted.
3.2.2.3.12	7.12, 6.1.08	The IAS shall be capable of processing MSCD to generate scan mirror and scan line corrector mirror models.
3.2.2.3.13	5.13	The IAS shall be capable of compensating for inoperable and saturated detectors during Level 1R and 1G processing.
3.2.2.3.14	8.04	The IAS shall be capable of compensating for the image artifacts of striping, banding, coherent noise, memory effect, and scan-correlated shift in Level 1R and 1G processing.
3.2.2.3.15	6.1.10	The IAS shall be capable of processing to Level 1R and 1G both ascending and descending pass ETM+ Level 0R data.
3.2.2.3.16		Deleted.

8.5 Performance Evaluation

3.2 REQS	Test Case	REQUIREMENTS SUMMARY
3.2.2.4.1	5.13	The IAS shall evaluate the on-orbit operability of ETM+ detectors.
3.2.2.4.2	Analysis	The IAS shall be able to evaluate the absolute radiometric accuracy of ETM+ Level 0R, 1R, and 1G data.
3.2.2.4.3	8.04, 8.05, 8.08, 8.10	The IAS shall be able to assess the identified ETM+ radiometric image artifacts of striping; banding; random, correlated, and coherent noise; memory effect; and scan-correlated shift.
3.2.2.4.4	8.07	The IAS shall be able to evaluate the MTF of each ETM+ detector.
3.2.2.4.5	5.24	The IAS shall be able to evaluate the SNR of each ETM+ detector, using prelaunch and on-orbit image data.
3.2.2.4.6	Analysis	The IAS shall be capable of evaluating the on-orbit radiometric response of each ETM+ detector with respect to dynamic range.
3.2.2.4.7	Analysis	The IAS shall be capable of evaluating the on-orbit radiometric response of each ETM+ detector, excluding band 6, with respect to linearity (TBD).
3.2.2.4.8	8.11 - 8.19, 6.3.03	The IAS shall be able to evaluate the geodetic accuracy of ETM+ Level 1G image data.
3.2.2.4.9	6.3.03	The IAS shall be able to evaluate the internal geometric accuracy of ETM+ Level 1G image data.
3.2.2.4.10	6.3.02	The IAS shall be able to evaluate the band-to-band registration accuracy of ETM+ imagery.
3.2.2.4.11	6.3.01	The IAS shall be able to evaluate the image-to-image registration accuracy of ETM+ data.

3.2 REQS	Test Case	REQUIREMENTS SUMMARY
3.2.2.4.12	4.03, 4.04, 4.05, 5.17, 8.02, 8.17, S1.17	The IAS shall be able to evaluate the quality ofLevel 0R products. Quality checks will include but not be limited to those listed in Table 3.2.2.4-1.
3.2.2.4.13	5.19, 5.21	The IAS shall be capable of performing a trend analysis over any desired time interval for each selected evaluation activity.
3.2.2.4.14		Moved to 3.2.4.14.
3.2.2.4.15	S1.18	The IAS shall provide the capability to visually inspect image data.
3.2.2.4.16	5.22, 5.23, 5.24, S1.05, S1.06	The IAS shall provide a capability that allows an image analyst to monitor assessment processes and results.
3.2.2.4.17	S1.19	The IAS shall have the capability to review output data including but not limited to calibration reports and updates.

8.6 Incorporation of New Algorithms

3.2 REQS	Test Case	REQUIREMENTS SUMMARY
3.2.2.5.1	S1.02	The IAS shall have the capability to acquire, develop, test, and add new algorithms and software to improve the radiometric and geometric properties of ETM+ data and their assessment without impacting IAS operations.
3.2.2.5.2	S1.02	The IAS shall support the development of algorithms to remove image artifacts and detector outages from Level1R and 1G data without impacting normal IAS operations.
3.2.2.5.3	S1.01	The IAS shall have the capability to incorporate new algorithms into the operational system without impacting normal IAS operations.
3.2.2.5.4	S1.00, S1.01, S1.02	The IAS shall maintain configuration control of all algorithms, databases, software, and hardware used in operations.

8.7 Processes Control and Manage Data

3.2 REQS	Test Case	REQUIREMENTS SUMMARY
3.2.2.6.1	1.04,1.17 -1.28, 5.07 - 5.11, 5.15, 5.16, S1.07, S1.08	The IAS shall be provide the capability to select the processing to be applied to data sets.
3.2.2.6.2	S1.02, S1.03, S1.04	The IAS shall be capable of archiving all software and databases used in operations.
3.2.2.6.3	S1.03, S1.04	The IAS shall be capable of storing selected data, parameters, ancillary data, reports, and documents.
3.2.2.6.4	2.01 - 2.08, 2.12, 2.13, 3.04, 3.05, 3.07, 4.01, 4.02, 4.03, 4.07, 4.08, 4.11	The IAS shall have the ability to monitor and control processes.
3.2.2.6.5	2.07	The IAS shall be capable of storing selected GCPsand GCP chips.
3.2.2.6.6	2.06	The IAS shall be capable of storing selected DEMs.
3.2.2.6.7		Deleted.
3.2.2.6.8	2.00	The IAS shall be capable ofstoring solar spectral and broadband radiance data.

3.2 REQS	Test Case	REQUIREMENTS SUMMARY
3.2.2.6.9	S1.03, S1.04	The IAS shall have the capability to write outputs to tape.
3.2.2.6.10	8.01 - 8.19	The IAS shall have the capability to generate hardcopy output.
3.2.2.6.11	S1.03, S1.04	The IAS shall archive selected prelaunch data, including but not limited to sensor engineering, ETM+ image data, alignment matrices, calibration measurements, mirror scan profiles, FASC BRDF, relative spectral subsystem response on a detector-by-detector basis, and required characterization data for performing in-flight calibrations.
3.2.2.6.12	2.09, 2.11	The IAS shall allow the operator to select thresholds for results and errors reported by the IAS.
3.2.2.6.13	1.08, 1.09, 2.11, 3.06, 4.10, 4.11, 5.12, 6.1.09, 6.2.05, 6.3.07	The IAS shall automatically generate messages and alarms to alert the operator to IAS results and errors that exceed selected thresholds.

8.8 Reports & Summaries

3.2 REQS	Test Case	REQUIREMENTS SUMMARY
3.2.2.7.1	1.06, 8.03, 8.06, 8.09, 8.15, 8.16, 8.18, 8.19, S1.17	The IAS shall generate calibration, data quality assessment, and problem reports.
3.2.2.7.2	TBD	The IAS shall be capable of generating metadata for all reports sent to the EDC DAAC Guide server.
3.2.2.7.3	1.06, 5.16, S1.18	The IAS shall generate annual reports that document calibration coefficient and performance analysis trends.
3.2.2.7.4	1.06, 8.03, S1.17	The IAS shall generate reports of anomaly detection analyses as they appear.
3.2.2.7.5	1.06, 8.10, 8.03 - 8.08, 8.11 - 8.14, 8.17, S1.13, S1.14	The IAS shall generate processing summaries after each IAS activity.

8.9 Performance Requirements Accuracy

3.2 REQS	Test Case	REQUIREMENTS SUMMARY
3.2.3.1	7.01	The IAS shall be capable of calibrating the radiometric response (absolute spectral radiance) of each operable ETM+ detector to an accuracy of 5 percent, 1 sigma, providing all inputs are within specification.
3.2.3.2	7.02	The IAS shall be capable of calibrating the relative radiometric response such that the ratio of ETM+ equivalent at-aperture radiances between any combination of two spectral bands, excluding band 6, shall vary less than 2 percent, 1 sigma, over a 7-day period when exposed to a spectrally constant source.
3.2.3.3	7.03	The IAS shall contribute no greater than 0.7 percent uncertainty to absolute radiometric accuracy during the generation of Level 1R and 1G data.

3.2 REQS	Test Case	REQUIREMENTS SUMMARY
3.2.3.4	7.04	The IAS shall be able to create systematic imagery to a geodetic accuracy of 250 meters, 1 sigma, providing all inputs are within specification. Performance applies to along-track and cross-track directions and is referenced to a nadir-viewing geometry.
3.2.3.5	7.05	The IAS shall contribute circular errors no greater than 1.8 meters, 1 sigma, in the production of systematically corrected ETM+ Level 1G imagery. This error is referenced to a nadir-viewing geometry and excludes the effect of terrain correction.
3.2.3.6	7.06	The IAS shall provide the capability to register pixels from a band to the corresponding pixels of the other bands in a common scene to an accuracy of 0.28 sensor GSD, 0.9p, in along-track and cross-track directions, providing all inputs are within specification. The accuracy is relative to the largest sensor GSD of the registered bands.
3.2.3.7	7.07, 6.3.02	The IAS shall contribute error no greater than 0.11 multispectral sensor GSD, 0.9p, along-track, and 0.24 multispectral sensor GSD, 0.9p, cross-track in the assessment of band-to-band registration.
3.2.3.8	7.07, 6.3.02	The IAS shall provide the capability to perform image-to-image registration to an accuracy of 0.4 multispectral sensor GSD, 0.9p, in the along-track and cross-track directions, providing all inputs are within specification.
3.2.3.9	7.08, 6.3.04	The IAS shall contribute circular errors no greater than 3.6 meters, 1 sigma, during image-to-image registration correction of ETM+ Level 1G data. Error is referenced to a nadir-viewing geometry and excludes the effect of terrain correction.
3.2.3.10	7.09, 6.3.05	The IAS shall be capable of estimating the field angles to an accuracy of 0.18 arcsec, 1 sigma.
3.2.3.11	7.10	The IAS shall be capable of digitally correlating common features in separate bands of the same image or same bands of separate images to an accuracy of 0.1 pixel, 0.9p.
3.2.3.12	6.3.02	The IAS shall be capable of estimating the alignment of the ETM+ line-of-sight to the satellite navigation base reference to an accuracy of 24 arcsec, 1 sigma, in all axes.
3.2.3.13		Deleted.

8.10 Throughput

3.2 REQS	Test Case	REQUIREMENTS SUMMARY
3.2.3.14	4.06	The IAS shall be capable of generating the equivalent of up to 10 ETM+ Level 1G systematically corrected scenes in a 24-hour day over the life of the mission. (**NOTE**: This requirement is meant to size the maximum capacity of the system)
3.2.3.15	4.06	The IAS shall be capable of receiving and storing 10 ETM+ Level 0R scene products or equivalent per day of data from the EDC DAAC.
3.2.3.16	S1.03, S1.04	The IAS shall be capable of archiving test site image data (initial, intermediate, and final products), characterization data, calibration data, calibration parameter files, and reports, generated by the IAS, over the life of the mission.
3.2.3.17	8.13 - 8.19, 8.11	The IAS shall generate monthly reports that document the quality of 0R data and 0R products retrieved from the EDC DAAC.

3.2 REQS	Test Case	REQUIREMENTS SUMMARY
3.2.3.18	8.19	The IAS shall provide regular calibration and performance updates to the EDC DAAC and other interfaces quarterly.
3.2.3.19	8.19	The IAS shall provide an annual Landsat7 image quality report.
3.2.3.20	4.10	The IAS shall have an on-line data storage capacity of 100 GB (TBR) for image data.
3.2.3.21	4.10	The IAS shall be capable of storing 68 MB of GCP data (points, chips, metadata).
3.2.3.22	4.10	The IAS shall capable of storing 20 GB of elevation data.

8.11 Operational Requirements

3.2 REQS	Test Case	REQUIREMENTS SUMMARY
3.2.4.1		Deleted.
3.2.4.2	S1.08	The IAS shall support end-to-end testing before launch.
3.2.4.3	S1.09	The IAS shall be capable of supporting full operations at launch-6 months.
3.2.4.4	Analysis	The IAS shall support mission operations for a minimum of 5 years following IOC.
3.2.4.5	N/A	The IAS shall operate two shifts for 7 days a week during IOC plus 48 days (TBR).
3.2.4.6	N/A	The IAS shall be staffed during prime shift post-IOC plus 48 days (TBR).
3.2.4.7	S1.10	The IAS shall ensure backup of all on-line data and operations software.
3.2.4.8	1.06, 5.17, 8.01, 6.2.02, 6.3.06	The IAS shall perform calibrations, assessments, and evaluations with frequencies specified in Tables 3.2.4-1 and 3.2.4-2.
3.2.4.9	S1.00, S1.11, S1.14	The IAS shall have the capability to maintain and upgrade all operational software.
3.2.4.10	S1.01, S1.12	The IAS shall be capable of supporting training without impacting daily work loads.
3.2.4.11	S1.13	The IAS shall provide an operational availability of 0.85 (TBR) or better for all processing functions.
3.2.4.12	S1.14	The IAS shall support an MTTR capability of 12 (TBR) hours or better.
3.2.4.13	S1.15	The IAS shall be capable of retrieving cross-calibration data of other sensors from the EDC DAAC.
3.2.4.14	S1.16	The IAS capability shall be used in performing anomaly, assessment, resolution, and reporting.

Section 9 Requirements & Verification Matrix

Verification Matrix for IAS 3.2 Element Specifications

I=Inspection A=Analysis D=Demonstration T=Test

9.1 Interface Requirements

3.2 REQS	REQUIREMENTS SUMMARY	I	A	D	T
3.2.1 Interface Requirements (EDC DAAC, IAS, MOC, MMO)					
3.2.1.1.1	The IAS shall interface with the EDC DAAC for purposes of searching for and ordering of data from the Landsat 7 archive.				x
3.2.1.1.2	The IAS shall receive Level 0R data and Level 0R products and associated ancillary data from the EDC DAAC.				x
3.2.1.1.3	The IAS shall interface with the EDC DAAC to coordinate the transfer of calibration parameter files and IAS-generated reports.			x	
3.2.1.1.4	The IAS shall send calibration parameter files and IAS-generated reports to the EDC DAAC.				x
3.2.1.2.1	The IAS shall interface with the LPS to coordinate the transfer of calibration parameter files and reprocessing requests.			x	
3.2.1.2.2	The IAS shall send reprocessing requests to the LPS.				x
3.2.1.2.3	The IAS shall receive disposition of reprocessing requests from the LPS.				x
3.2.1.2.4	The IAS shall send calibration parameter files to the LPS.				x
3.2.1.3.1	The IAS shall send requests to the MOC for the operational acquisition of partial-aperture calibration data, full-aperture calibration data, and surface image data of radiometric and geometric calibration ground sites.				x
3.2.1.3.2	The IAS shall coordinate with the MOC for the acquisition of ETM+ imagery required for calibration and image assessment, for transfer of calibration parameter files, and for transfer of problem reports.			x	
3.2.1.3.3	The IAS shall send requests to the MOC for concentrated definitive ephemeris.				x
3.2.1.3.4	The IAS shall send problem reports to the MOC.				x
3.2.1.3.5	The IAS shall send calibration parameter files to the MOC.				x
3.2.1.3.6	The IAS shall be capable of receiving trend reports, spacecraft status reports, and event schedules from the MOC.				x
3.2.1.3.7	The IAS shall be capable of receiving FDF-generated definitive ephemeris from the MOC.				x
3.2.1.4.1	The IAS shall send problem reports and summary reports to the MMO.			x	

3.2 REQS	REQUIREMENTS SUMMARY	I	A	D	T
9.2 Radiometric Calibration					
3.2.2.1.1	The IAS shall be able to use data from the internal calibrator in the calibration of the radiometric response of each ETM+ detector.				x
3.2.2.1.2	The IAS shall be able to calibrate the radiometric response of each ETM+ detector, except band 6, using data from the PASC.		x		x
3.2.2.1.3	The IAS shall be able to calibrate the radiometric response of each ETM+ detector, except band 6, using data from the FASC.		x		
3.2.2.1.4	The IAS shall be able to calibrate the radiometric response of each ETM+ detector given Level 0R data of a ground calibration site and corresponding at-aperture spectral radiance values.		x		x
3.2.2.1.5	The IAS shall be able to calibrate the radiometric response of each ETM+ detector using Level 0R data from preship and prelaunch calibration sources and auxiliary calibration source data.				x
3.2.2.1.6	The IAS shall have the capability of assessing the short-term and long-term stability of the onboard calibration sources, which include the FASC, the PASC, and the internal calibrators.			x	
3.2.2.1.7	The IAS shall be able to integrate the results of the various calibration processes into an optimal estimate of radiometric calibration of each detector (except band 6) and provide new calibration parameters.		x		
3.2.2.1.8	The IAS shall be capable of generating radiometric calibration updates for the calibration parameter file.				x
3.2.2.1.9	The IAS shall be able to transfer the calibration of each detector to the internal calibrator.				x
9.3 Geometric Calibration					
3.2.2.2.1	The IAS shall be capable of determining the misalignment between the satellite navigational base reference and the ETM+ payload LOS.				x
3.2.2.2.2	The IAS shall be capable of determining band-to-band registration parameters.				x
3.2.2.2.3	The IAS shall be capable of characterizing and updating along and across scan parameters (i.e, scan mirror profiles, scan corrected mirror profile, detector offsets, detector delays).				x
3.2.2.2.4	The IAS shall be capable of generating geometric calibration updates for the calibration parameter file.				x
9.4 Level 1 Processing					
3.2.2.3.1	The IAS shall be capable of processing PCD data to correct spacecraft time, generate sensor pointing model (attitude and jitter), and calculate spacecraft position and velocity (Ephemeris).				x
3.2.2.3.2	The IAS shall be capable of processing ETM+ Level 0R products to produce radiometrically corrected Level 1R image data.				x
3.2.2.3.3	The IAS shall be capable of creating systematically corrected ETM+ Level 1G imagery from Level 0R products.				x

3.2 REQS	REQUIREMENTS SUMMARY	I	A	D	T
3.2.2.3.4	The IAS shall be capable of creating precision corrected ETM+ Level 1G imagery from Level 0R products and GCPs.				x
3.2.2.3.5	The IAS shall be capable of creating terrain corrected ETM+ Level 1G imagery from Level 0R products, GCPs, and elevation data.				x
3.2.2.3.6	The IAS shall be capable of performing image-to-image registration.				x
3.2.2.3.7	The IAS shall be capable of incorporating IAS-generated calibration coefficient updates to generate Level 1 data.				x
3.2.2.3.8	The IAS shall support nearest neighbor, cubic convolution, and MTF compensation resampling.				x
3.2.2.3.9	The IAS shall have the capability to produce a 1G product with a grid cell size that is variable from 15 to 60 meters, in increments of 1 mm.				x
3.2.2.3.10	The IAS shall have the capability to map project 1G using the Space Oblique Mercator, Universal Transverse Mercator, Lambert Conformal Conic, Transverse Mercator, Oblique Mercator, and Polyconic coordinate reference systems.				x
3.2.2.3.11	The IAS shall have the capability to create a 1G image oriented to nominal path or north-up.				x
3.2.2.3.12	Deleted.				
3.2.2.3.12	The IAS shall be capable of processing MSCD to generate scan mirror and scan line corrector mirror models.				x
3.2.2.3.13	The IAS shall be capable of compensating for inoperable and saturated detectors during Level 1R and 1G processing.				x
3.2.2.3.14	The IAS shall be capable of compensating for the image artifacts of striping, banding, coherent noise, memory effect, and scan-correlated shift in Level 1R and 1G processing.				x
3.2.2.3.15	The IAS shall be capable of processing to Level 1R and 1G both ascending and descending pass ETM+ Level 0R data.				x
3.2.2.3.16	Deleted.				
9.5 Performance Evaluation					
3.2.2.4.1	The IAS shall evaluate the on-orbit operability of ETM+ detectors.		x		
3.2.2.4.2	The IAS shall be able to evaluate the absolute radiometric accuracy of ETM+ Level 0R, 1R, and 1G data.		x		
3.2.2.4.3	The IAS shall be able to assess the identified ETM+ radiometric image artifacts of striping; banding; random, correlated, and coherent noise; memory effect; and scan-correlated shift.				x
3.2.2.4.4	The IAS shall be able to evaluate the MTF of each ETM+ detector.		x		
3.2.2.4.5	The IAS shall be able to evaluate the SNR of each ETM+ detector, using prelaunch and on-orbit image data.		x		x
3.2.2.4.6	The IAS shall be capable of evaluating the on-orbit radiometric response of each ETM+ detector with respect to dynamic range.		x		
3.2.2.4.7	The IAS shall be capable of evaluating the on-orbit radiometric response of each ETM+ detector, excluding band 6, with respect to linearity (TBD).		x		

3.2 REQS	REQUIREMENTS SUMMARY	I	A	D	T
3.2.2.4.8	The IAS shall be able to evaluate the geodetic accuracy of ETM+ Level 1G image data.				x
3.2.2.4.9	The IAS shall be able to evaluate the internal geometric accuracy of ETM+ Level 1G image data.		x		
3.2.2.4.10	The IAS shall be able to evaluate the band-to-band registration accuracy of ETM+ imagery.				x
3.2.2.4.11	The IAS shall be able to evaluate the image-to-image registration accuracy of ETM+ data.				x
3.2.2.4.12	The IAS shall be able to evaluate the quality ofLevel 0R products. Quality checks will include but not be limited to those listed in Table 3.2.2.4-1.				x
3.2.2.4.13	The IAS shall be capable of performing a trend analysis over any desired time interval for each selected evaluation activity.			x	
3.2.2.4.14	Moved to 3.2.4.14.		x		x
3.2.2.4.15	The IAS shall provide the capability to visually inspect image data.			x	
3.2.2.4.16	The IAS shall provide a capability that allows an image analyst to monitor assessment processes and results.			x	
3.2.2.4.17	The IAS shall have the capability to review output data, including but not limited to calibration reports and updates.			x	
9.6 Incorporation of New Algorithms					
3.2.2.5.1	The IAS shall have the capability to acquire, develop, test, and add new algorithms and software to improve the radiometric and geometric properties of ETM+ data and their assessment without impacting IAS operations.		x	x	
3.2.2.5.2	The IAS shall support the development of algorithms to remove image artifacts and detector outages from Level1R and 1G data without impacting normal IAS operations.			x	
3.2.2.5.3	The IAS shall have the capability to incorporate new algorithms into the operational system without impacting normal IAS operations.			x	
3.2.2.5.4	The IAS shall maintain configuration control of all algorithms, databases, software, and hardware used in operations.		x	x	
9.7 Processes Control and Manage Data					
3.2.2.6.1	The IAS shall be provide the capability to select the processing to be applied to data sets.				x
3.2.2.6.2	The IAS shall be capable of archiving all software and databases used in operations.		x	x	
3.2.2.6.3	The IAS shall be capable of storing selected data, parameters, ancillary data, reports, and documents.				x
3.2.2.6.4	The IAS shall have the ability to monitor and control processes.				x
3.2.2.6.5	The IAS shall be capable of storing selected GCPsand GCP chips.			x	
3.2.2.6.6	The IAS shall be capable of storing selected DEMs.			x	
3.2.2.6.7	Deleted.				
3.2.2.6.8	The IAS shall be capable ofstoring solar spectral and broadband radiance data.			x	

3.2 REQS	REQUIREMENTS SUMMARY	I	A	D	T
3.2.2.6.9	The IAS shall have the capability to write outputs to tape.				x
3.2.2.6.10	The IAS shall have the capability to generate hardcopy output.				x
3.2.2.6.11	The IAS shall archive selected prelaunch data, including but not limited to sensor engineering, ETM+ image data, alignment matrices, calibration measurements, mirror scan profiles, FASC BRDF, relative spectral subsystem response on a detector-by-detector basis, and required characterization data for performing in-flight calibrations.				x
3.2.2.6.12	The IAS shall allow the operator to select thresholds for results and errors reported by the IAS.				x
3.2.2.6.13	The IAS shall automatically generate messages and alarms to alert the operator to IAS results and errors that exceed selected thresholds.				x
9.8 Reports and Summaries					
3.2.2.7.1	The IAS shall generate calibration, data quality assessment, and problem reports.				x
3.2.2.7.2	The IAS shall be capable of generating metadata for all reports sent to the EDC DAAC Guide server.				x
3.2.2.7.3	The IAS shall generate annual reports that document calibration coefficient and performance analysis trends.			x	
3.2.2.7.4	The IAS shall generate reports of anomaly detection analyses as they appear.			x	
3.2.2.7.5	The IAS shall generate processing summaries after each IAS activity.				x
9.9 Performance Requirements Accuracy					
3.2.3.1	The IAS shall be capable of calibrating the radiometric response (absolute spectral radiance) of each operable ETM+ detector to an accuracy of 5 percent, 1 sigma, providing all inputs are within specification.		x		x
3.2.3.2	The IAS shall be capable of calibrating the relative radiometric response such that the ratio of ETM+ equivalent at-aperture radiance s between any combination of two spectral bands, excluding band 6, shall vary less than 2 percent, 1 sigma, over a 7-day period when exposed to a spectrally constant source.		x		x
3.2.3.3	The IAS shall contribute no greater than 0.7 percent uncertainty to absolute radiometric accuracy during the generation of Level 1R and 1G data.		x		x
3.2.3.4	The IAS shall be able to create systematic imagery to a geodetic accuracy of 250 meters, 1 sigma, providing all inputs are within specification. Performance applies to along-track and cross-track directions and is referenced to a nadir-viewing geometry.		x		x
3.2.3.5	The IAS shall contribute circular errors no greater than 1.8 meters, 1 sigma, in the production of systematically corrected ETM+ Level 1G imagery. This error is referenced to a nadir-viewing geometry and excludes the effect of terrain correction.		x		x

3.2 REQS	REQUIREMENTS SUMMARY	I	A	D	T
3.2.3.6	The IAS shall provide the capability to register pixels from a band to the corresponding pixels of the other bands in a common scene to an accuracy of 0.28 sensor GSD, 0.9p, in along-track and cross-track directions, providing all inputs are within specification. The accuracy is relative to the largest sensor GSD of the registered bands.		x		x
3.2.3.7	The IAS shall contribute error no greater than 0.11 multispectral sensor GSD, 0.9p, along-track, and 0.24 multispectral sensor GSD, 0.9p, cross-track in the assessment of band-to-band registration.				x
3.2.3.8	The IAS shall provide the capability to perform image-to-image registration to an accuracy of 0.4 multispectral sensor GSD, 0.9p, in the along-track and cross-track directions, providing all inputs are within specification.				x
3.2.3.9	The IAS shall contribute circular errors no greater than 3.6 meters, 1 sigma, during image-to-image registration correction of ETM+ Level 1G data. Error is referenced to a nadir-viewing geometry and excludes the effect of terrain correction.		x		x
3.2.3.10	The IAS shall be capable of estimating the field angles to an accuracy of 0.18 arcsec, 1 sigma.		x		x
3.2.3.11	The IAS shall be capable of digitally correlating common features in separate bands of the same image or same bands of separate images to an accuracy of 0.1 pixel, 0.9p.				x
3.2.3.12	The IAS shall be capable of estimating the alignment of the ETM+ line-of-sight to the satellite navigation base reference to an accuracy of 24 arcsec, 1 sigma, in all axes.		x		x
3.2.3.13	Deleted.				
9.10 Throughput					
3.2.3.14	The IAS shall be capable of generating the equivalent of up to 10 ETM+ Level 1G systematically corrected scenes in a 24-hour day over the life of the mission. (**NOTE**: This requirement is meant to size the maximum capacity of the system)				x
3.2.3.15	The IAS shall be capable of receiving and storing 10 ETM+ Level 0R scene products or equivalent per day of data from the EDC DAAC.				x
3.2.3.16	The IAS shall be capable of archiving test site image data (initial, intermediate, and final products), characterization data, calibration data, calibration parameter files, and reports, generated by the IAS, over the life of the mission.		x	x	
3.2.3.17	The IAS shall generate monthly reports that document the quality of 0R data and 0R products retrieved from the EDC DAAC.				x
3.2.3.18	The IAS shall provide regular calibration and performance updates to the EDC DAAC and other interfaces quarterly.			x	
3.2.3.19	The IAS shall provide an annual Landsat 7 image quality report.				x
3.2.3.20	The IAS shall have an on-line data storage capacity of 100 GB (TBR) for image data.			x	

3.2 REQS	REQUIREMENTS SUMMARY	I	A	D	T
3.2.3.21	The IAS shall be capable of storing 68 MB of GCP data (points, chips, metadata).			x	
3.2.3.22	The IAS shall capable of storing 20 GB of elevation data.			x	
9.11 Operational Requirements					
3.2.4.1	Deleted.				
3.2.4.2	The IAS shall support end-to-end testing before launch.			x	
3.2.4.3	The IAS shall be capable of supporting full operations at launch-6 months.			x	
3.2.4.4	The IAS shall support mission operations for a minimum of 5 years following IOC.		x		
3.2.4.5	The IAS shall operate two shifts for 7 days a week during IOC plus 48 days (TBR).	N/	A		
3.2.4.6	The IAS shall be staffed during prime shift post-IOC plus 48 days (TBR).	N/	A		
3.2.4.7	The IAS shall ensure backup of all on-line data and operations software.			x	
3.2.4.8	The IAS shall perform calibrations, assessments, and evaluations with frequencies specified in Tables 3.2.4-1 and 3.2.4-2.		x	x	
3.2.4.9	The IAS shall have the capability to maintain and upgrade all operational software.			x	
3.2.4.10	The IAS shall be capable of supporting training without impacting daily work loads.		x	x	
3.2.4.11	The IAS shall provide an operational availability of 0.85 (TBR) or better for all processing functions.		x		x
3.2.4.12	The IAS shall support an MTTR capability of 12 (TBR) hours or better.		x		x
3.2.4.13	The IAS shall be capable of retrieving cross-calibration data of other sensors from the EDC DAAC.				x
3.2.4.14	The IAS capability shall be used in performing anomaly, assessment, resolution, and reporting.		x		x

Glossary of Terms

0R: The stage in the processing before radiometric or geometric correction of an image and after the pixels have been placed in detector spatial order.

0R product: Products distributed by the EDC DAAC, to include all bands; 0R image data, metadata, radiometric calibration data, calibration parameter file, payload correction data (PCD), and MSCD.

1R: The stage in the processing after radiometric correction has been applied to an image.

1G: The final stage in the processing after radiometric and geometric corrections have been applied to the image data.

Ancillary data: Spacecraft attitude and ephemeris, radiometric correction coefficients, geometric processing parameters, and image quality statistics.

Archive: Off-line storage of data, software, and documentation.

ASPAM: A model that creates a report on meteorological conditions, including such items as pressure, temperature, and water vapor content as a function of altitude, at a particular time and place, derived from empirical and interpolated data by USAFETAC (more than 48 hours after the fact).

Bright Target Recovery: Also known as memory effect.

Calibration activities: Recalculating of the radiometric correction coefficients or geometric processing parameters.

Data storage: On-line storage of data accessible to the various functions within the IAS.

Dead detectors: Nonresponsive detectors.

Degraded detectors: Also known as inoperable detectors (see definition).

Equivalent at-aperture radiance: Estimated radiance from other than full-aperture radiance.

Entrance aperture radiance: Actual full-aperture radiance.

ETM+ Equivalent Scene:

L0R image data (6320+225) x 5984 x 6 + ((12640 +450) x 11968) + ((3160 + 113) x 2992x2) = 0.41 GB

Level 1G, nonrotated, resampled to 25m (except Pan to 12.5m)
220km x 170km/(.025km/pix)^2 x 2 bytes/pix x 7 bands +
220km x 170km/(.0125km/pix)^2 x 2 bytes/pix = 1.3 GB

Geodetic accuracy: The accuracy relative to the geodetic reference surface, the Earth ellipsoid.

Geometric accuracy: The measure of internal distortion of an image.

Geometric artifacts: Assessment of geometric artifacts (or assessment of geometric accuracy) includes visual assessment of discontinuities of linear features, scale distortion, panoramic distortion, and any other distortions.

Geometric processing parameters: Orbit parameters, instrument and alignment parameters, focal plane band locations, scan mirror profile coefficients (along scan and across scan), odd detector sample shifts, alignment matrixes, Angular Displacement Sensor (ADS) calibration parameters, gyro calibration parameters, along scan focal plane detector offsets, temperature calibration coefficients, inoperable modes, resampling coefficients, MTF coefficients, and MTF compensation.

Ground look calibration: The process of radiometrically calibrating the payload, on-orbit, by comparing payload readings to estimated radiances reaching the payload from ground scenes using onsite ground and atmospheric measurements.

Ground measurement data: Also known as ground truth data.

- Normal image data of ground truth site collected in low gain mode
- In-band target radiance measurements coincident with the Landsat 7 overpass
- In-band irradiance measurements of the ground
- Temperatures of the water at selected depths from the surface to 1 meter below the surface (for band 6 calibration)
- Air temperature and wind speed and direction just above the water temperature probes (for band 6 calibration)
- Atmospheric measurements, to include
  - Pressure, temperature, and relative humidity/water vapor density as a function of altitude as reported by radiosondes launched within 1 hour before the overpass of Landsat 7
  - Surface-level pressure, temperature, and relative humidity/water vapor density
  - Surface-level aerosol measurements and a ground visibility measurement within one-half hour of the overpass
  - Lidar measurements of water vapor density as a function of altitude within 5 minutes of the overpass
- Full ASPAM report from USAFETAC for comparison

In-orbit checkout (IOC): The 45-day period specified after launch during which spacecraft and sensor systems are activated, checked out, outgassed, and initially calibrated.

Initial operational capability: Milestone after satellite initialization and checkout wherein operations are transferred from the developers (NASA) to the system operators (NOAA).

Inoperable detectors: Detectors meeting the following criteria shall be declared inoperable:

- The quantized digital number (DN) is below 50 percent of the full-scale DN value when a detector is exposed to the ETM+ minimum saturation levels.
- The quantized DN reaches full scale while the input radiance is at or below 0.70 times the ETM+ minimum saturation levels.
- The SNR performance degrades to 50 percent or below the specified ETM+ minimum SNR values.

Level 0R scene product: See *0R product.*

Level 1G data: Includes both 1G imagery and geometric correction data.

Level 1G imagery: Image data that have been geometrically corrected.

Payload correction data (PCD): The PCD contain all data required by ground stations to geometrically correct ETM+ sensor data and redundantly provide the ETM+ imaging configuration. The PCD are embedded in every wideband data virtual channel data unit (VCDU) at a rate of 4 bytes of PCD per VCDU. PCD data items are

- ADS
- ADS temperature
- Gyro data
- Gyro drift data
- Attitude estimate
- Time of last SV clock update
- SV time drift characterization data
- Ephemeris
- ETM+ telemetry data
- Spacecraft ID and time code
- Multiplexer status
- PDF A/D ground reference
- Minor frame sync
- Major frame identification
- Spacecraft identifier
- Attitude control system mode
- ETM+ on/off times

Radiometric processing parameters: Includes the radiometry parameters in the calibration parameter file (prelaunch gains, initial post launch gains, most current gains, detector status table, offset window locations, nominal biases, and scale factors) plus IAS-maintained calibration parameters from individual calibration sources and the combined radiometric model (CRAM).

Radiometric image artifacts: Striping, banding, scan correlated shift, bright target recovery response (aka memory effect), coherent noise, impulse noise, detector saturation, and detector inoperability.

Test sites: Geometric test sites include five primary sites:

- Iowa (Path 28, Row 30)
- EROS (Path 29, Row 29)
- Texas (Path 28, Row 37)
- Northern Minnesota (Path 28, Row 27)
- Colorado Springs (Path 33, Row 33)

Test sites include 3 secondary sites:

- Iowa II (Path 27, Row 30)
- Iowa III (Path 26, Row 30)
- Wichita (Path 28, Row 34)

Radiometric test sites include

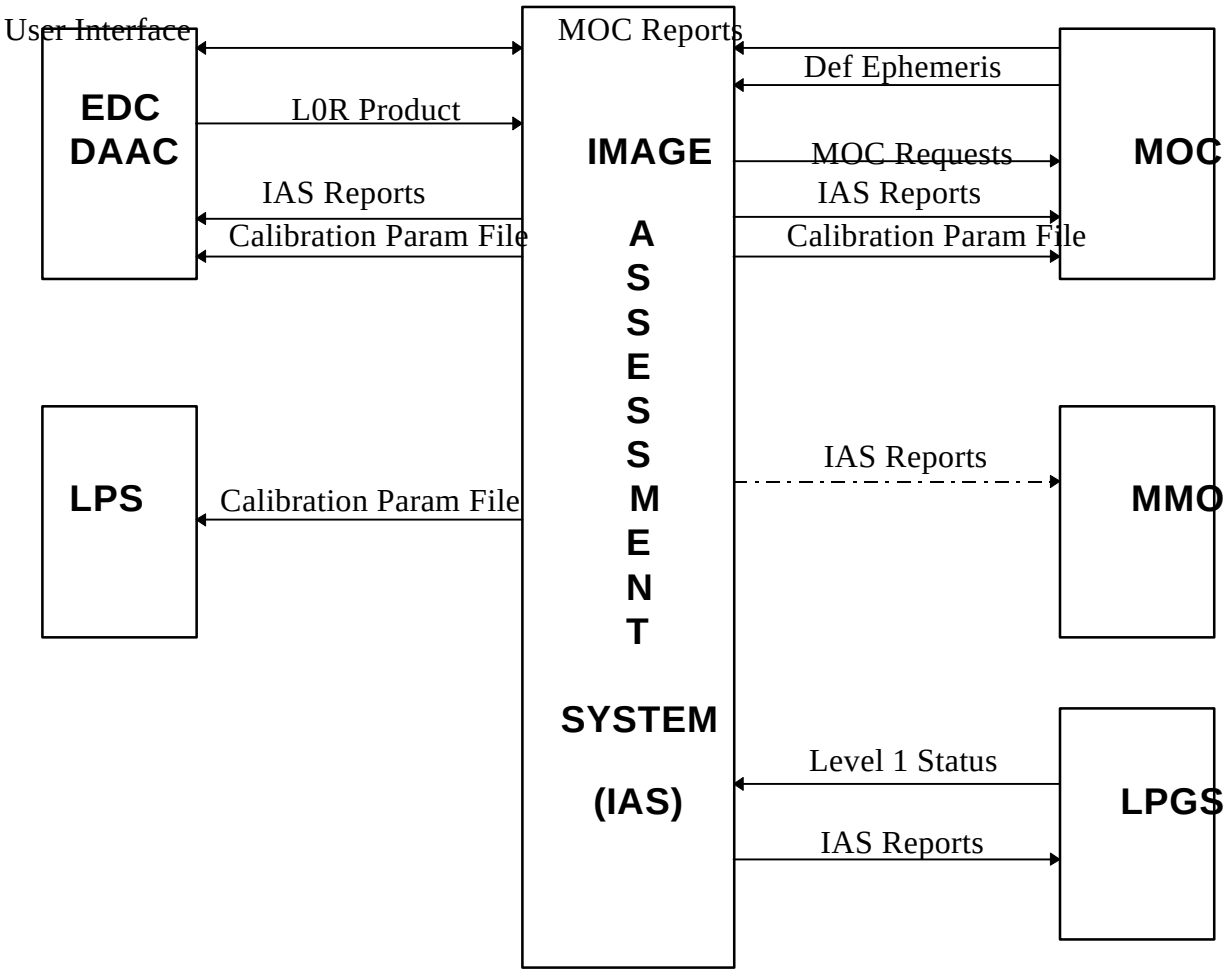
- White Sands Alkali Flats, NM (33N, 106W)
- Rogers Dry Lake Bed, CA (35N, 118W)
- Lake Tahoe, CA (40N, 120W)

Acronyms

ACCA	Automated Cloud Cover Assessment
ADS	Angular Displacement Sensor
BRDF	Bi-directional Reflectance Distribution Function
CRAM	combined radiometric model
DEM	digital elevation model
DMR	detailed mission requirements
DN	digital number
EDC	EROS Data Center
EDC DAAC	EROS Data Center Distributed Active Archive Center
EROS	Earth Resources Observation System
ETM+	Enhanced Thematic Mapper Plus
FASC	full-aperture solar calibrator
FDF	Flight Dynamics Facility
FHSERR	First Half Scan Error
GB	gigabyte
GCP	ground control point
GSD	guide star data
GSFC	Goddard Space Flight Center
IAS	Image Assessment System
IGS	International Ground Station
IOC	In-orbit checkout
LMMS	Lockheed Martin Marietta Space
LOS	line-of-sight
LPS	Landsat 7 Processing System
LSQAT	Landsat Quality Assurance Team
MB	megabyte
mm	millimeter
MMO	Mission Management Office

MOC	Mission Operations Center
MSCD	Mirror Scan Correction Data
MTF	Modulation Transfer Function
MTTR	mean time to restore
NASA	National Aeronautics and Space Administration
PASC	partial-aperture solar calibrator
PCD	Payload Correction Data
SBRC	Santa Barbara Research Center; Division, Hughes Aircraft
SHSERR	Second Half Scan Error
SNR	signal-to-noise ratio
VCDU	virtual channel data unit
WRS	Worldwide Reference System

Appendix A



indirect Interface _ - _ - _ - _ - _ - _ - _ - _ - _ - _ - _ - _ - _

Direct Interface _____